NATURE MAGAZINE

ne-July, 1945 35 Cents Vol. 38, No. 6

SEVENTY-TWO AMERICAN BIRD SONGS

ON PHONOGRAPH RECORDS

American Bird Songs

These Phonograph Bird Song Records are from the Laboratory of Ornithology, Cornell University. They were recorded in Native Wilds by the Albert R. Brand Bird Song Foundation.

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THE PROCESS OF RECORDING

These recordings were all made in the birds' natural haunts. The scientists used a sensitive microphone at the focal point of a three-foot parabolic sound-reflector which was aimed, like a gun, at the singing bird. The sound waves thus intercepted were transformed by the microphone into electrical impulses, much amplified in a sound-truck, and then used to vibrate a delicate galvanometer on which was fastened a tiny mirror. A slender beam of light shining on this vibrating mirror was deflected to a 16-millimeter film which passed from one magazine to another at a constant rate of speed. Thus the bird's song was photographed so that the image or sound-track developed on the film could be used in a reverse process and made to reproduce the song, which was then, in the laboratory, recorded on a phonograph disk.

The bird's song had to be amplified several thousand times. That means that extraneous sounds, such as wind in trees, running water, airplanes, farm machinery, and notes of other birds were amplified too. For that reason many promising attempts at recording proved failures. The songs here recorded represent the best results of many efforts.

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Birds of the Northwoods

No. 1 A	*No. 1 B*
1. Olivebacked Thrush	1. Scarlet Tanager
2. Veery	2. Rose-breasted Grosbeak
3. Wood Thrush	3. Slate-colored Junco
4. Hermit Thrush	4. Yellow-bellied Sapsucker
5. White-throated Sparrow	5. Alder Flycatcher
6. Whip-poor-will	6. Olive-sided Flycatcher

Birds of Fields and Prairies

No. 4 A	*No. 4 B*
1. Bobolink	1. Prairie Horned Lark
2. Meadowlark	2. Savannah Sparrow
3. Western Meadowlark	3. Lark Sparrow
4. Vesper Sparrow	4. Killdeer
5. Field Sparrow	5. Spotted Sandpiper
6. Red-winged Blackbird	6. Burrowing Owl

Birds of Northern Gardens and Shade Trees

No. 2 A	*No. 2 B*
1. Song Sparrow	1. Chickadee
2. Robin	2. Wood Pewee
3. Catbird	3. Chipping Sparrow
4. Baltimore Oriole	4. Red-eyed Vireo
5. Yellow Warbler	5. Yellow-throated Vireo
6. Flicker	6. Warbling Vireo

North American Game Birds

No. 5 A	*No. 5 B*
1. Ruffed Grouse	1. Gambel's Quail
2. Bob-white	2. California Quail
3. Wild Turkey	3. White-winged Dove
4. Dusky Grouse	4. Woodcock
5. Prairie Chicken	5. Canada Geese
6. Chachalaca	6. Mallard Duck

Birds of Southern Woods and Gardens

No. 3 A	*No. 3 B*
1. Indigo Bunting	1. Mockingbird
2. Pine-woods Sparrow	2. Brown Thrasher
3. Pine Warbler	3. Cardinal
4. Orchard Oriole	4. Summer Tanager
5. Yellow-breasted Chat	5. Chuck-will's-widow
6. Carolina Wren	6. Barred Owl

Birds of Western North America

No. 6 A	*No. 6 B*
1. Wren Tit	1. Lazuli Bunting
2. California Thrasher	2. Blue Grosbeak
3. Nuttall's Sparrow	3. California Shrike
4. Fox Sparrow	4. California Purple Finch
5. Western Tanager	5. Plumbeous Vireo
6. Black-headed Grosbeak	6. California Woodpecker

★

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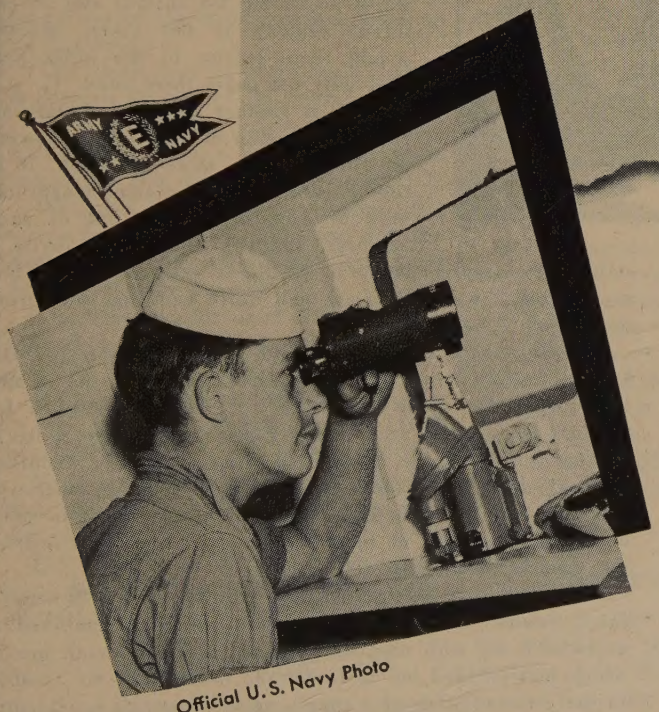

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Nature in Print

By HOWARD ZAHNISER

A FEW weeks ago I read Victor Wolfgang von Hagen's *South America Called Them: Explorations of the Great Naturalists—La Condamine, Humboldt, Darwin, Spruce,* and since then I have been reading or re-reading whatever my own small library has on South America.

It is surprising how much this library of mine, chosen at random afoot in second-hand book stores for the most part, has on South American natural history. Besides the selections in such collections as Beebe's *Book of Naturalists,* recently reviewed on this page, and the always fruitful articles in Britannica and other reference books, there are four books that are original contributions to South American natural history—chosen, however, not because of their reference to South America but rather because of their own interest and appeals.

There are two books from the inexpensive Everyman's Library. One of them, of course, is Charles Darwin's *Journal of Researches into the Geology and Natural History of the Various Countries Visited during the Voyage of H. M. S. Beagle Round the World.* The other is *The Naturalist on the River Amazons* by Henry Walter Bates, one of the most interesting journals of natural history exploration that I have ever read, and perfectly fascinating in its many and detailed descriptions of insects. W. H. Hudson's *The Naturalist in La Plata* is there because of the eloquence with which Hudson could tell of his observations and reflections. Finally, I have Theodore Roosevelt's *Through the Brazilian Wilderness,* describing the hazardous expedition that the ex-President made, with George K. Cherrie and Leo E. Miller of the American Museum of Natural History in his party.

Add to these the historical and descriptive, political or economic material that such a collection of books by a North American general reader contains, and it seems to me we have a good example of how well documented our consideration of the good neighbor policy can be. We are accustomed to hearing that we know little about South America, and undoubtedly we have been laggards in informing ourselves. Yet if my own experience means anything, there is much more known than our publicists give us credit for. Without setting out to study South America, we have acquired many books and much information simply because South America has so much that is interesting in and of itself. It takes only a centralizing interest around which all this can be related to emphasize how extensive it is.

Victor Wolfgang von Hagen's narrative of the explorations of four great naturalists effectively stirs up such an interest in this continent, and his title is a happy one—*South America Called Them*—although it is irrepressible to observe that many were called, but four chosen. Yet it is a good choice, good because these four naturalists explored so many different parts of South America, and good because their explorations cover such a long period of time.

"In 1861," as von Hagen writes, "Spruce stood on the shores of Guayaquil. It was a long time since La Condamine and his group from the French Academy had set themselves upon South American beaches and forced open the continent. In 1735 South America had been, to the world at large, as little known as the moon. Maps of it were filled with great voids, vast stretches of terra incognita. Now, in a single century and a quarter, explorer-naturalists had woven about it a criss-cross of travel-ways and exploratory roads."

The adequate although generalized maps that von Hagen includes among his well-chosen illustrations show how much of the continent he has been able to cover. Charles-Marie de la Condamine's explorations included not only the Amazon but both Atlantic and Pacific coast regions of the north, as well as the isthmus of Panama. Alexander von Humboldt sought out the secret of the Orinoco, explored the mountainous regions from Lima on north as far as South America goes, climbed so high on Chimborazo that ever afterwards he was proud of this ascent, and in the Pacific itself made the observations of the remarkable cold stream now called in his honor the Humboldt Current. Charles Darwin toured the coast of nearly all of the continent not associated with La Condamine or Humboldt, made some excursions inland, and explored many islands, including those critically important islands described in von Hagen's chapter entitled "The Galapagos Begets Evolution."

Richard Spruce's botanizing explorations were along the Amazon, the Negro up beyond the Casiquiare to the Orinoco, and beyond the Pastaza over the mountains to Guayaquil on the Pacific.

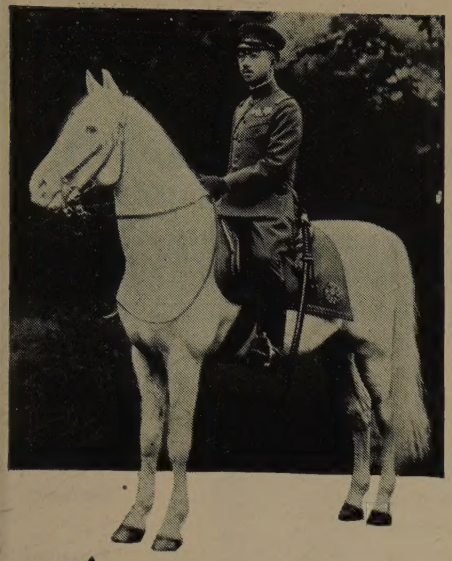
This book is rich in "incidents" too, and they are made to seem not only strange and exciting but also significant. In one place von Hagen observes: "*L'affaire Jemmy* can take its place beside the haunting tragedy of Mme Godin, the War of Jenkins' Ear, and the captivity of Aime Bonpland in Paraguay as the stories that brought attention to the continent." These stories are all here, and the book would be well worth possessing for curious and adventurous reading if the owner merely sought these entries in the index and read only the pages there cited.

There is another good fortune of von Hagen's selection of only four explorers around which to write his book. It is thus possible to write at some length not only of each exploration but of each explorer, and von Hagen does write a satisfactory complete sketch of the life of each naturalist. They are naturalists whose lives are well worth knowing, aside from their South American calls.

The importance of Humboldt and that of Darwin are well known. La Condamine was a correspondent of all the savants in Europe. "He wrote of rubber . . . he introduced it for the first time to the scientists of Europe. . . . Then, when it was not rubber, curare, quinine, smallpox, physics or chemistry with which La Condamine was busy, it was the science of measurement. He wanted the countries of the world to adopt a common standard of measurement . . . from this evolved the French metric system."

Richard Spruce was a man who could write: "Whenever rains, swollen streams and grumbling Indians combined to overwhelm me with chagrin, I found reason to thank heaven which had enabled me to forget the moment of my troubles in the contemplation of a simple moss." It seems providential that Spruce did have such resources of satisfaction for, unlike the other great naturalists in this book, he was without spectacular awards.

"He had done so much for South America and for science," writes von Hagen, "yet, on his return to England, there were no parades, no universal celebrations such as were held for Humboldt; no such formal gatherings of academies as marked the return of the French Academicians; no burial in Westminster Abbey, like that accorded Darwin. He, who had opened



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Admiral Halsey has his eye on a fine white horse called Shirayuki.

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the green world of the Amazon, who had spent fifteen years in the jungles and the rock-hard world of the cordilleras, was met by no one other than his old botanical friends. . . . . They tried to find this tall, amiable, soft-spoken, fever-racked man a sinecure of some sort to help him weather the financial storms that would beset him. The most they could secure for the man who brought India a quinine industry, who helped provide the means by which man made his conquest of the tropics, who had collected 30,000 plants and made the gardens at Kew world-renowned, was a pitiful fifty-pound annual pension."

Varied as the interests in this book are, its dominant interest throughout is indeed the great continent, and, particularly, its natural history. The author himself is an explorer with a live interest in natural history. He too has been called to Ecuador, Peru, the Amazon, the Galapagos Islands, and other parts of Middle and South America, and in a final chapter he interprets the call that South America is still making—for a complete book on mammals, one on birds, one on plant geography, and still other needs. He himself has done much to answer the call for a book to make the whole of the continent exist in the understanding of North American readers. Whether *South America Called Them* proves to be for a reader the introduction to South American natural history, or a centralizing influence of diversified reading, it is too important to be left on the booksellers' shelves. The best approach of all to an understanding of this part of the world in which we have become so politically concerned is through a knowledge of its geography and natural history, and von Hagen makes this approach refreshing and interesting.

South America Called Them: Explorations of the Great Naturalists—La Condamine, Humboldt, Darwin, Spruce. By Victor Wolfgang von Hagen. New York: Alfred A. Knopf. 1945. 311 pp., with 32 illustrations (including 4 maps, 4 portraits, 22 reproductions of illustrations from old books, and 2 photographs by the author), bibliographical references, chronology 1498-1859, and index. $3.75.

Ecuadorean Botany

Ecuador's University has commenced the publication of a monthly called *The Bulletin of the Botanical Institute of the Central University of Quito*, covering the plant life of Ecuador and neighboring republics, health and sanitation in the tropics, geology and bibliography, Dr. Alfredo Paredes C., Instituto Botanico de la Universidad Central, Quito, Ecuador, would like to exchange this publication with those of a similar nature brought out by school, colleges, museums and governmental agencies.

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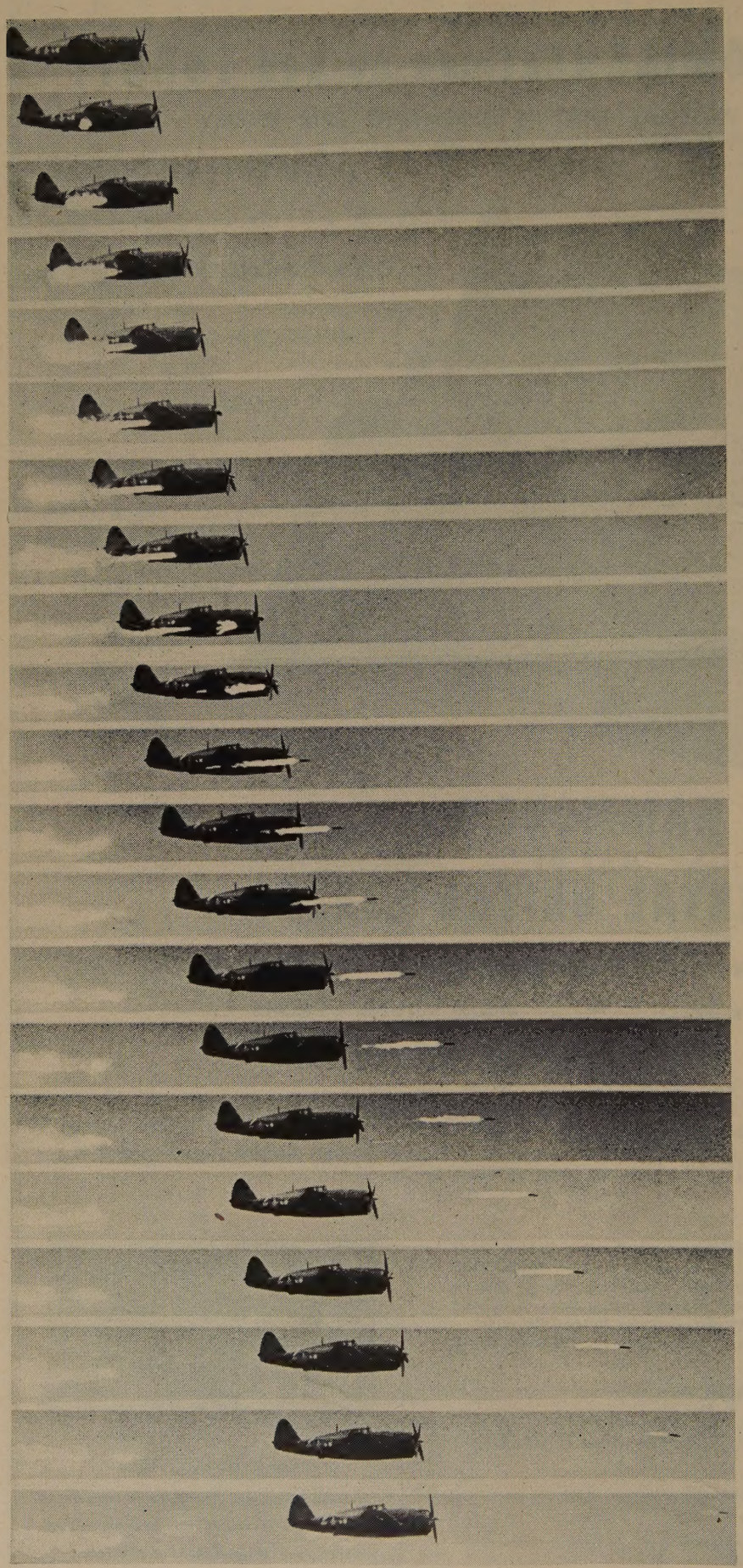

Succession pictures taken by a "ribbon frame" camera, showing a wing rocket getting under way and speeding toward the enemy at about 13 miles a minute. This camera was developed by Bell Telephone Laboratories.

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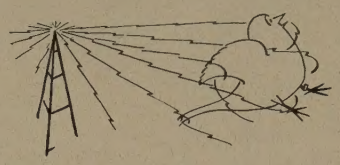
Contents Noted

ONE of our readers, reading the little article about Weepy, the Swoose, in the March issue, ventured the opinion that a swoose—a cross between swan and goose—was not possible. Lest others may cherish similar doubts may we say that it is not only possible, but the number of authenticated swooses is considerable. Swan-goose romances in zoos and aviares are numerous. In the *Auk* for January, 1928, the late Dr. John C. Phillips describes a hybrid resulting from the union of an Australian black swan and a female Canada goose, and there are pictures of the interesting bird to prove it. In fact, Dr. Phillips seems to have coined the name "swoose." Another reader questions the use of swoosling to describe a young swoose. He suggests swosling would be better, thus setting the stage for a world-shaking etymological argument.

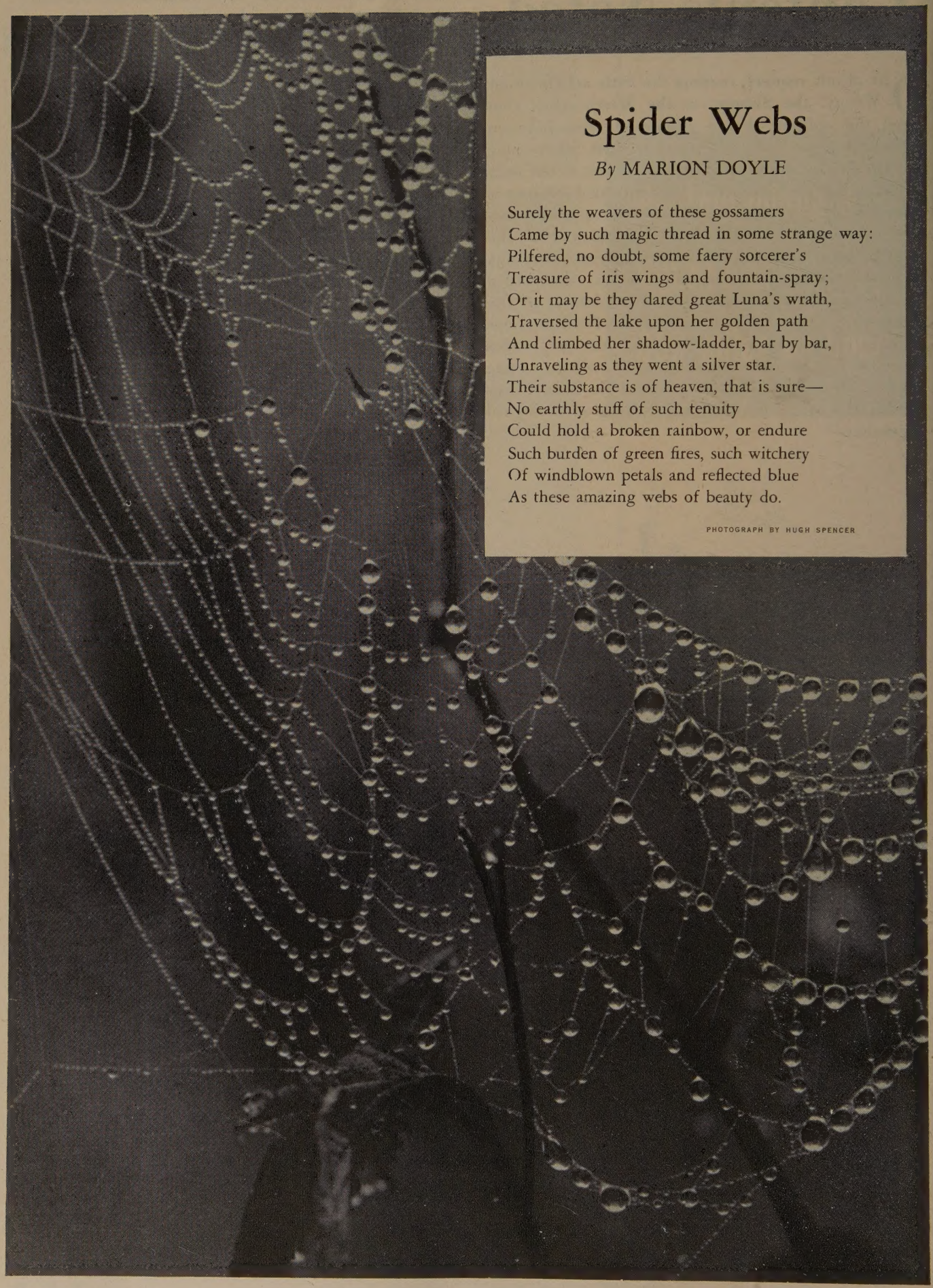
THROUGH the years we have received many, many letters asking for information or requesting little services. We have been able to respond helpfully and with reasonable alacrity to almost all of these. But one received recently really stumped us. A correspondent in British Columbia wrote that he had received an anonymous letter from someone in Troy, New York, berating him for shooting wildlife for sport. This worried our Canadian friend, who said that he never had shot for sport, and he asked us to see whether we could not find this Troy person and set him, or her, straight. We have little respect for people who write anonymous letters, and we are rather too busy right now to get out our Sherlock Holmes cap and run up to Troy. Besides, we have lost that shiny badge with "Detective" on it that we used to treasure way back in—well, way back.

THAT being a homing or "carrier" pigeon is a business complicated by the crowded ether waves of the air is suggested by tests made by the Army Signal Corps. Three different groups of ten pigeons each were subjected to successive tests. Five birds in each group were released, at different times, from a radio station that was broadcasting. Their lofts were only ten miles away, but these birds circled erratically and close to the station for a time, and finally made their home lofts in times varying between forty-two and fifty-two minutes. The other groups of five were released at times when the station was silent. They set off immediately for home, making the flight in from eighteen to twenty-one minutes. All thirty birds flew under practically identical conditions of weather and wind, and were birds of similar type and training. More tests will be made, but we might suggest that the birds that rode the radio waves could have been as confused as the housewife after a day of "soap operas", wondering which soap was best, and whether John's Other Wife met Helen Trent on the Road to Happiness.



NEXT to the Big Ditch, male headgear has probably served to publicize the name of Panama the most. However, Panama hats did not originate in Panama, are not woven under water, and are not made from the fibers of a palm. Some hats are fashioned from palm fiber, to be sure, but they are not the real thing. If the fibers are flat they are from a palm; if cylindrical they are true "Panama." An Ecuadoran is reported to have made the first of these hats about a decade after the Pilgrims set foot on Plymouth Rock. It was not until the middle of the nineteenth century, however, that prospectors returning from the California gold fields by way of the Isthmus brought some hats from Panama to the United States, and thus gave them the name. Now the hats are made in Ecuador, Colombia and other Latin American countries, being woven from a fiber furnished by shredding the immature, unopened leaves of the screw "pine", trees of the family Pandanaceae, which comprises many species of plants, sometimes small trees, inhabiting the East Indies and other lands in or bordering the Indian and central Pacific Oceans. Some of these are now widely spread in tropical America as ornamental or economic plants. The highest-quality hats are those with the most rings on the crowns.

AS A further report on the severe restriction of the sale of baby chicks at Easter, we are happy to add that the Illinois State Legislature has seconded the action of Chicago and passed a regulatory law. The drive for the law was led by the Chicago Anti-Cruelty Society. R. W. W.



Spider Webs

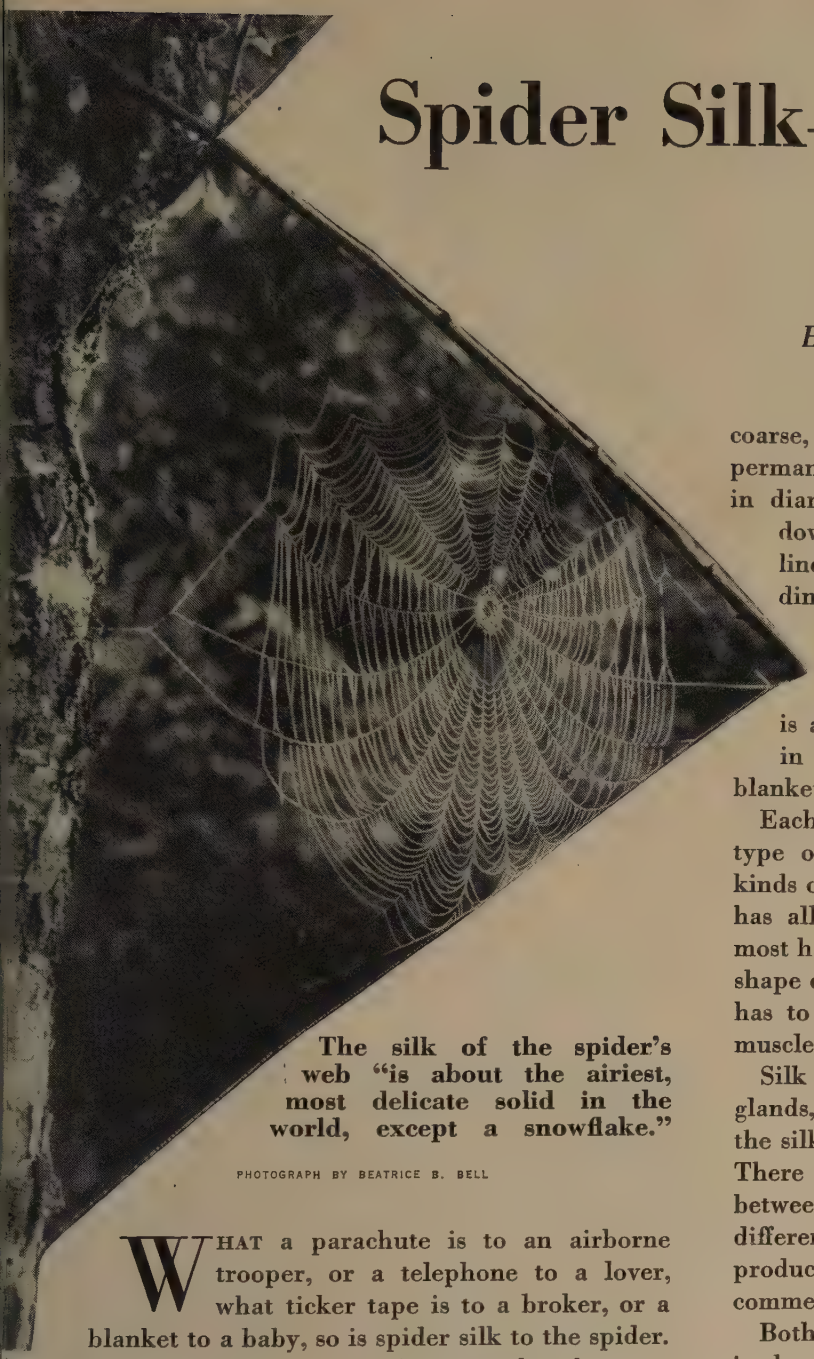
By MARION DOYLE

Surely the weavers of these gossamers
Came by such magic thread in some strange way:
Pilfered, no doubt, some faery sorcerer's
Treasure of iris wings and fountain-spray;
Or it may be they dared great Luna's wrath,
Traversed the lake upon her golden path
And climbed her shadow-ladder, bar by bar,
Unraveling as they went a silver star.
Their substance is of heaven, that is sure—
No earthly stuff of such tenuity
Could hold a broken rainbow, or endure
Such burden of green fires, such witchery
Of windblown petals and reflected blue
As these amazing webs of beauty do.

PHOTOGRAPH BY HUGH SPENCER

Spider Silk—Wonder-stuff of Nature

By DONALD CULROSS PEATTIE



The silk of the spider's web "is about the airiest, most delicate solid in the world, except a snowflake."

PHOTOGRAPH BY BEATRICE B. BELL

WHAT a parachute is to an airborne trooper, or a telephone to a lover, what ticker tape is to a broker, or a blanket to a baby, so is spider silk to the spider. She has more uses for it than a cowboy for rope or an engineer for steel. Indeed, some of this exquisite gossamer is actually stronger than steel would be if drawn out to a filament of the same diameter—say 1/1000 of an inch.

But the engineer does not produce his steel girders out of his own body glands, nor can a falling airman open a parachute when he has none. Only the spider can do such things.

To the spider, silk serves as a banquet hall and tablecloth, as a trap line and a foxhole, as a marriage bed and a winding sheet, as an alarm system and a fire escape, as handcuffs and a way of going places. It is the most versatile and marvelous substance produced by any living creature.

For spiders have a silk to meet every need and emergency of their lives. There is one sort, very coarse, often irregular in thickness, used to form the permanent frame of the web, and another, very even in diameter, by which mistress spider lets herself down and up. There is a dry cord for the radial lines on which the spider runs out to meet her dinner guests. But for these guests she reserves quite a different kind, on which she would not dream of setting foot; it is much too beautiful, and too sticky! And there is a thick, often brightly or heavily colored silk in which the eggs are encased—a sort of baby blanket for cold nights.

Each kind of gossamer is produced from a different type of gland inside the spider's abdomen. Seven kinds of silk gland are known; though no one species has all seven, every species has at least three and most have four. Each gland opens through a different shape of tube. Which kind to use, the spider no more has to stop and think than you have to select the muscles that will snatch your fingers from a burn.

Silk it definitely is, this product of the spider's glands, quite as much as the textile fiber produced by the silkworm, that grub or larva of an oriental moth. There are minute technical and chemical differences between silkworm silk and spider's gossamer; but the differences may be in the favor of the spider, whose produce is often finer, flossier, and yet stronger than commercial silk.

Both are alike in existing in the glands as a liquid in the way that saliva or milk is found in a mammal's glands. But silk hardens on contact with the air, becoming immediately a solid. It is about the airiest, most delicate solid in the world, except a snowflake. Chemically considered, silk is an albuminous substance, a protein. Considered as a natural fiber, commercial silk is seen under the microscope to comprise two cylinders of tough matter (fibroin) enclosed in a satiny coating (sericin), and more or less waterproofed with a waxy matter.

But the wonder of spider silk is not the stuff itself but the little creature that spins it. If science will not allow that the spider is intelligent, her instincts and reactions are the equal of intelligence in their cunning and unerring performance. Spiders can measure angles and bisect them. They can judge, calculate and adjust stresses and strains. They understand, or at

least they employ, the principle of the strut and brace. They are as weather-wise as a barometer and know how to perceive and utilize wind directions. Popularly they are credited with being able to tie as many kinds of knot as a sailor. Actually this is untrue; their webs are not knotted, but spiders do "weld" joints —or something that corresponds to welding.

Not all spiders spin webs, and of those that do, the best spinners are usually the females; frequently the males make only temporary "bachelor diggings," or dwell in the nests of the female. There are probably as many kinds of web as there are species of spiders that spin. The simplest sort is the delicate hidden trap made by the common house spider and called "cobwebs." A much finer web is made by the grass spider, who spins a filmy platform with a funnel-shaped hide-out at the back; generally there is a vertical cobweb above this which serves to catch flying insects who then tumble into the "parlor" below, where they stick fast and are soon greeted by the little hostess who darts out from the funnel.

But the finest type of all, the height of spider art, is the orb web, built on the principle of spokes banded by circumferential lines. Some are suspended horizontally, some vertically, some at an angle. These are made by many kinds of spiders, all over the world, but the commonest orb-weaver is the so-called garden spider. Anybody with time and patience can watch the building of an orb web. True, most spiders are shy ladies and prefer to work at night, but if you will locate such a web by day, and take a flashlight out after dark, you may watch the spinstress on the job. It is well, though, not to shine the light directly on the web. The tricks of her trade are a guild secret.

The other day I had my first chance to watch a spider spinning in daytime. Her name was Miranda, according to my scientific books, and she was black with yellow bands. This particular specimen was a young female, hence she was still slender, not having lost her figure from egg-bearing, and her long slim legs were still handsomely clad in the black-and-yellow bands that denote youth in this species.

She had already built two sides of her triangular framework, of the heavy tough thread spiders use for that purpose. At the moment she was starting to make the third side. To do this she climbed back up the perpendicular line she had spun, all the time reeling out a new line, anchored at the base of her perpendicular line and held away from the old one with her hind legs. It looked like thread hanging from the needle of a woman sewing, as she laboriously made her way to the top, then walked down the inclined plane of the other completed side of her triangle. She did not walk upright, like a tight-rope walker, but slung herself underneath the wire, like a tree sloth inching along. When she got to the end she stopped, and reefed in her slack that she had been carrying and spinning, until it was taut. Then she fastened it to the twig from which she had started, with a little dab of mucilage-like matter from her glands, and so the third side of her triangular loom was complete.

Here she took a rest, and well she might. She had now to solve the problem of making the radial lines, or spokes, of her wheel. To do this she walked out to the middle of the top side of her triangle, made fast there the beginning of a line, and let herself down to the lower side, where she fastened the end of the line she carried. Then she crawled back up and located the center, by what capacity to measure distance we can only guess. This was to be the hub of her wheel. Here she fastened a new line, which she carried free as she climbed to the top of her triangle, crawled a way along the top of her frame, took in her slack line, and fastened it. Now she had a radius, or, counting

To the spider the silken web serves, among other things, as a foxhole. Here a male grass spider, *Angelena naevia*, lurks at the entrance to his home awaiting the appearance of suitable prey.

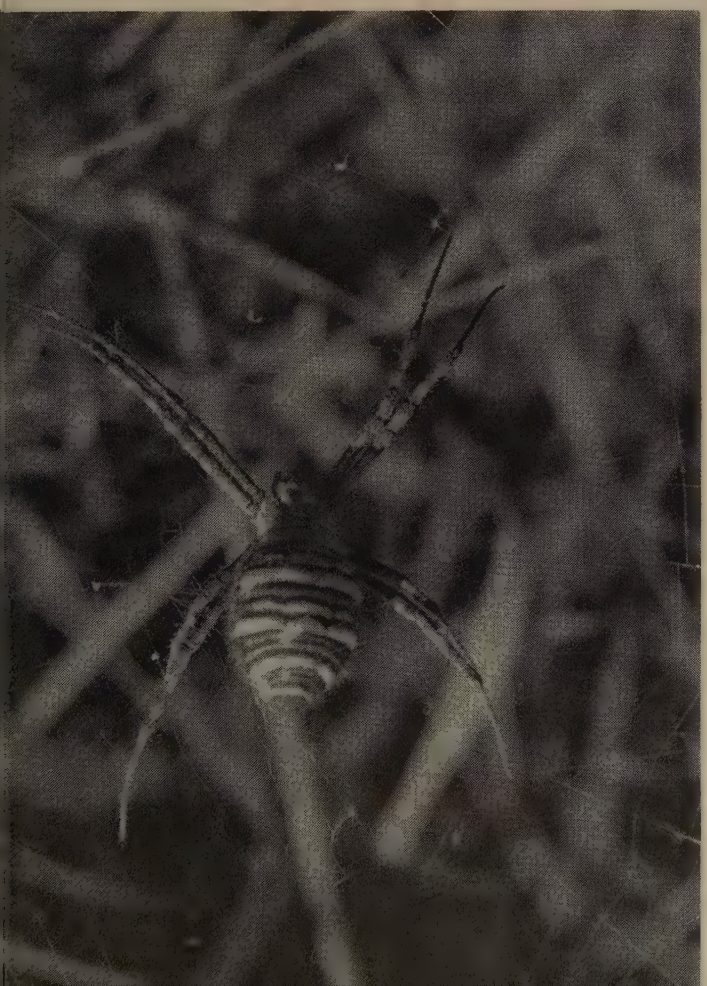
PHOTOGRAPH BY LEE PASSMORE

the two halves of her first diametrical lines, she now had three radii. And, going back each time to the center, she laboriously built one radius after the other.

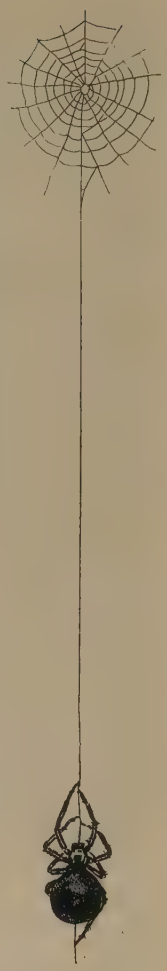
But not in regular succession. Oh, no, our little lady welder is too smart for that. She does not wish to put too many stresses on one side of the frame at once. Instead, she built first on one side, then on another, then to the right of center, then to the left. After that she rested, built a little hub, a sort of damask plaform, her future headquarters, and began to fill in more radii, working now on one side, now on the opposite, as a man tightens nuts on an auto wheel.

When she had nineteen radii in place, Miranda stepped slowly around just outside her hub, forefeet on one radius, hindfeet on another, pacing off the angles between them. At first she was satisfied. Then she found one angle that was twice as wide as it should be. Quickly she filled it in with a twentieth radius; that seemed to be the number that pleased her. Perhaps Miranda could count, but even if not she could do something much more wonderful—she could measure angles, about eighteen degrees in this case, far more exactly than I could do it without a graduated scale! She was, indeed, an able engineer.

"The other day I had my first chance to watch a spider spinning in the daytime. Her name was Miranda, according to my scientific books, and she was black with yellow bands."



Miranda now took another rest. Her body, if not her head, was tired. The human head is the seat of thought. But who can say where the instincts (which replace thought in the lower animals) reside? Who can say where they come from, how they are handed down? The art of weaving by spiders descends, primarily, on the distaff side, from mother to daughter. But presumably Miranda never saw her mother weave a net, and she could not have learned by imitation if she had. Her first bit of workmanship was as good as any she will ever make. And Miranda, in her turn, will never see her children as anything but eggs. Yet she will hand on her exquisite craft to them with the very chromosomes of her reproductive cells.



Her rest over, Miranda began to weave outward from the hub a spiral band, in the nature of a scaffolding to brace the radii for the stresses she is about to put on them. She gave the spiral four and a half turns.

Then, walking deliberately out to the end of one of the lower radii, she began for the first time to spin a sticky stuff; I could see it come gushing from her glands, glistening like dew. It is elastic, too, so that it will not snap; indeed, the victim who gets into its toils will merely entangle himself more with every exertion. Miranda lays a few bands of it on the bottom half of the web, a few bands at the top. Then she goes to the bottom again and builds more concentric lines of what is, in essence, so much sticky fly-paper. Thus, working her way to the center, Miranda encounters the spiral scaffolding and begins to tear it out, as a tailor tears out basting threads. She does not want to leave this nice, dry, escape ladder for any fly to use! As fast as she removes it she replaces it with the sticky loops. But she stops well short of the hub, her personal living quarters.

At last the little miracle is finished, the toil of four and a half hours, counting brief rests. It is the most complex structure built by any living creature. A bird's nest is clumsy beside it, and the vaunted comb of the honeybee monotonous and simple in comparison. The spider web is the work of a little engineer without diploma, of a geometrician who never heard of Euclid, of a weaver whose design never falters.

Miranda's work was three times interrupted by the collision of flies with the unfinished net. Each time Miranda tore along one of the radial lines, taking care not to tangle with the sticky circumferential ones, and nipped the arrival once. The tiny drop of venom paralyzed the victim instantly. Then Miranda

PHOTOGRAPH BY WILLIAM M. SAVIN

The large web of a grass spider. This one measures two and one-half feet from the spider's retreat to the extreme end of the web, which is sheet-like with some irregular lines above to arrest passing insects. These drop into the larger sheet of the spider's web.

began to truss it up. From my position under the web I could see the winding silk gush out from her belly like milk, to harden instantly. The hind legs, provided with comb-like claws, raked the strands forward as a comb draws tresses through it; they were passed under the belly to the forefeet and wrapped swiftly around the now quiescent prey. When the fly had disappeared entirely from view, Miranda went quietly back to her work. Dinner could wait.

Grasshoppers, locusts, all sorts of insect pest are the natural prey of our ally the spider. Mice and even snakes have been known to get caught in spider webs, and in some cases the spider is able to kill them. I never but once sympathized with a spider's victim. That was when I saw in my California garden a hummingbird struggling frantically in the web of a huge spider. From time to time the spider darted at the bird but drew back before the fluttering wings. The bird showed every sign of fear and had completely lost its head, fouling itself worse in the sticky web. Climbing a ladder, I fetched the bird down, its plumage so glued by the sticky threads it could not fly. I bathed it, wiped it, and had the satisfaction of seeing the bird dart away with a joyful hum.

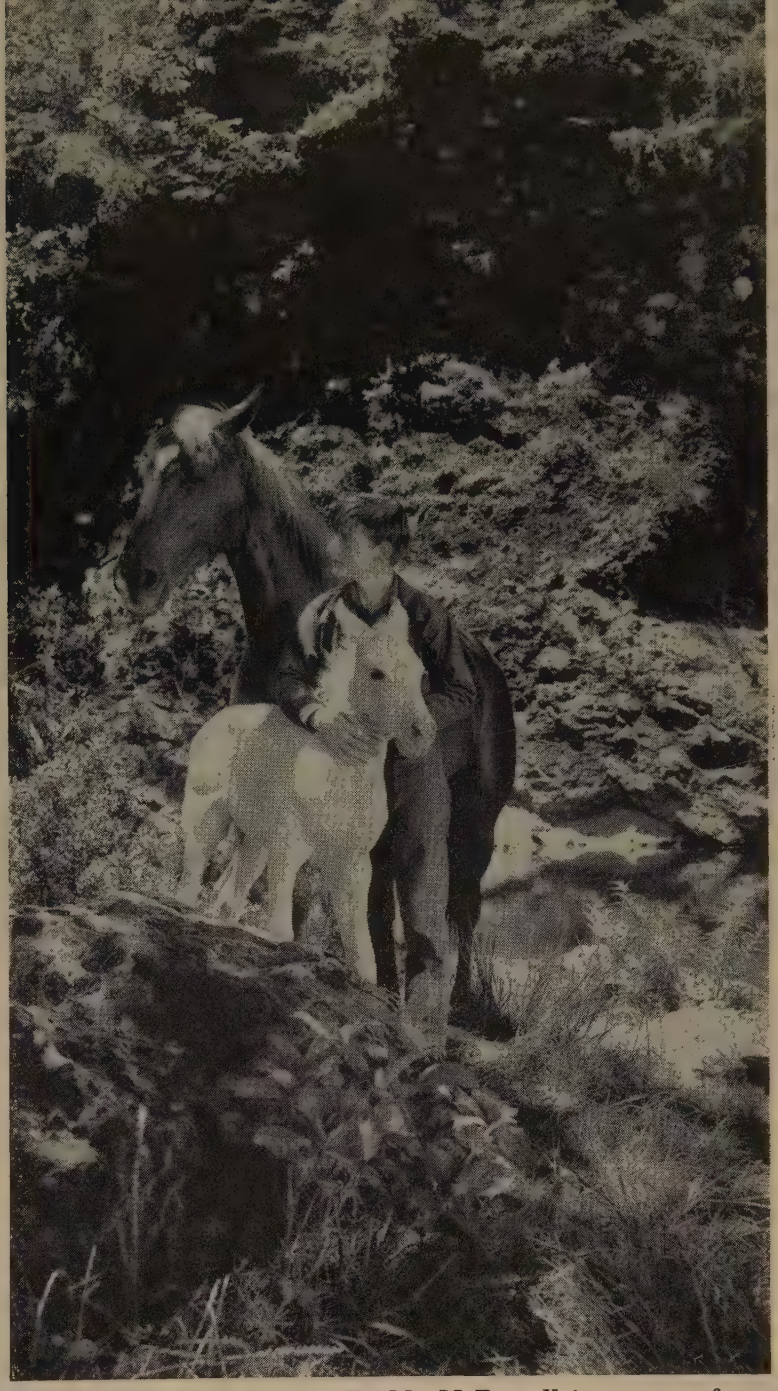
For some spiders the silken cables of their web serve like telegraph lines. The male, coming to the edge of the net, plucks it until the lady responds by running out to meet him. Or she may answer by plucking the threads herself a while, a sort of telephone conversation. The European diving spider makes a diving bell of silk and goes under the water, still able to breathe beneath the bell.

Of an autumn night certain kinds of small spiders, apparently seized with the desire to go places and see things, spin out a thread of silk into the wind until it is buoyant enough to bear their weight. Then they let go their perch and allow themselves to be carried away by these tiny silken parachutes. Thousands may alight in a single meadow. The early riser in the country will then see it sheeted completely over in that elfin phenomenon "a fall of gossamer." Charles Darwin, on the ship *Beagle*, noted the arrival of hosts of tiny spiders on the deck of the ship sixty miles from the coast of South America.

Even man has his uses for spider silk. In New Guinea certain tribes are said to induce spiders to spin webs inside hoops on long handles; these are apparently strong enough to serve for fish nets. A textile silk can be spun from certain spiders in Madagascar; it is reeled out of the living spider's bodies, being first started by hand and then twined mechanically into a thread, and woven into cloth. It has been claimed that more than 200 feet of fiber an hour can be thus extracted, and after a rest the spider can be put to work again. Although we have a similar spider in this country—*Nephila*, (Continued on page 330)

Motion Picture Animals Have a Champion

By GRACE V. SHARRITT



Flicka, Thunderhead and Roddy McDowall in a scene from the Twentieth-Century-Fox film "Thunderhead", which was made under American Humane Association supervision.

THE little old lady fidgeted in the theatre seat beside me during the opening scene in the motion picture, "Thunderhead." "That poor little thing," she muttered, while the audience, as one, held its breath, mentally and spiritually struggling to push a young albino colt up a steep gully bank during a terrific electrical storm. When Roddy McDowall finally gathered into his arms what he could of a frisky-legged, baby horse, we sat back and heaved a sigh.

There is suspense, drama and good filming in this fine realistic picture that stars horses, and that is what we had paid our money to see. Yet we need not have shivered with the colt in the storm, or grieved, later, about the stallions that fight, presumably, to the death. As far as actual injury to the animals goes there was none, of course.

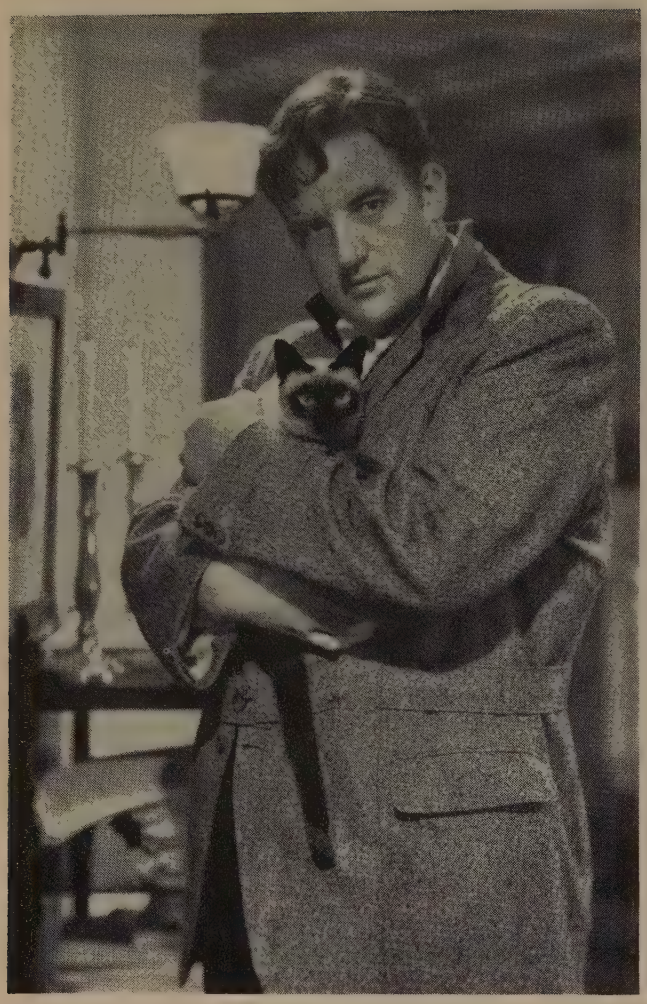
Why "of course"? one might ask. The title flashed on the screen at the beginning of "Thunderhead" sets forth a unique credit line—"The producers are grateful for the invaluable assistance and approval of the American Humane Association, under whose supervision this picture has been made."

Richard Craven, Western Representative of the American Humane Association, and interpreter of humane sentiment for animals for the Hays Office, permitted the use of this credit line.

As he told me, "I granted permission for the title because one of my assistants, or myself, was on the set every moment of the production of 'Thunderhead,' as we are for every picture starring or using animals. You can assure the public that there is no abuse of motion picture animals today."

"In the first place," said Mr. Craven, "the motion picture industry is a shrewd business. No good business is going to take risks that might stop a million-dollar production because of negligence or mistreatment that might result in loss of a horse or dog featured in a costly picture. Secondly, many motion picture producers, actors and trainers are almost silly in their sentiment for animals. They love Lassie and Daisy, Pi and Thunderhead, stars of recent pictures. They worry and fret if a horse, or dog, or cat gets hurt through some unpredictable accident."

There is the case of Dice. Dice is a beautiful pinto stallion trained to do tricks, such as counting by pawing the ground. He is highly intelligent. Jean Arthur rode him in "Arizona." He has a featured part in "Duel in the Sun." But Dice, like many another movie star, may have his moments of temperament.



The late Laird Cregar with the Siamese cat that took a thousand-dollar cat-nap during the filming of the Twentieth-Century-Fox picture, "Hangover Square."

One day, while on a set, he left the studio and started for his home stables before anyone missed him. He had no more than hit the high road when he was struck by a passing car. The studio was in an uproar. During Dice's convalescence he received telegrams, flowers and telephone calls from solicitous admirers, just as Betty Grable or Hedy LaMarr might receive them. Motion picture people love animals, and most of them have pets of some kind, ranging from lion cubs to Persian cats, and from poodles to marmosets.

Then there was the Siamese cat that plays in the sinister film, "Hangover Square," with the late Laird Cregar. The cat disappeared from his scene when he was supposed to be curled up on a grand piano. For one solid hour the studio held up production hunting for that cat. (The cost of making a picture is from seven to eight thousand dollars a day.) Finally one of the prop boys found the hero asleep in a far corner beneath the stage. The animal-actor cost the studio about one thousand dollars for his cat-nap.

Was he scolded? Or brushed by a broom, as many a housewife might have done? No, indeed! Was he even suspended, as another lesser star might have been? No!

"You see," said Mr. Craven, "he was absolutely necessary to that picture. And, anyway, the actors all liked him."

In the old days, when Pearl White thrilled the "silents" with harrowing jumps from precipices, horses were often hurt. There was then employed what was called the "Running W." It was a device wired from the forelegs of a horse. When the horse was required to fall in a scene, he would be galloped the full length of the wire only to be jerked suddenly off his feet. Sometimes his neck was broken. Movie directors who loved horses refused to make pictures in which horses were to appear.

Since Mr. Craven's appointment to Hollywood in December, 1940, it is forbidden even to rescreen a picture of those days showing the "Running W." And any studio resorting to the use of this device would be barred by the Code Administration under Hays Office rules, which specifically forbid any cruelty to animals in motion pictures.

Contrast the treatment of horses called upon to fall in pictures today. They are trained to fall on signal. The first trick taught them is to lie down. Next they learn to go down while walking; finally, to fall down at a gallop while carrying a man. The horse is never tired out while being schooled and all the training is done on soft ground.

"Wherever a horse is to fall," says Mr. Craven, "the ground is dug to a depth of eighteen inches. Stones and clods of earth are removed and everything has to be completely satisfactory to the humane officer on the job. The ground must be as soft as a sandpile, for if a horse is hurt when falling he will not do the trick again. Hence his value as a falling horse is lost."

The Hays Office would hold up release of a picture if scenes featuring animals were obtained by cruel methods. Mr. Craven is usually given the script of major productions. If he makes suggestions to alter certain scenes that may involve risks to animal actors he receives the closest cooperation from director and producer.

For instance, the movie, "National Velvet," reproduces the world-famous Grand National Steeplechase. In the actual event in England it often happens that horses—sometimes riders—are killed. This must not happen in a movie. For the picture the studio bought ten horses that were highly-trained jumpers, and hired about forty others. To reduce the risk to a minimum, the studio, on Mr. Craven's urging, engaged professional steeplechase riders from the Caliente and Pimlico tracks. Thus the horses had to carry less weight and had the confidence that comes from handling by professional jockeys. As a result, while there are spills in the picture, no horse sustained injury of any moment.

Hollywood does not like to disillusion its audiences with technical secrets. Yet many harrowing details

The fight that causes question as to the abuse of animals in "Thunderhead". Neither horse was hurt in the least, thanks to humane supervision and Hollywood's art with a camera.

on a screen are merely good make-up, trick photography, and excellent cooperation from highly intelligent animals. The storm in "Thunderhead", for example, seemed to be blinding sheets of rain, but was nothing but water run out of overhead pipes combined with trick photographing. The tortuous gully bank that the helpless Thunderhead struggles to scale, only to slip and fall time after time, was padded with heavy felt. The producer, Robert Bassler, laughed in reminiscence when he spoke of that scene.

"The colt was as frisky as a lamb after the filming of that particular scene. He played with Roddy and ran around the lot. Of course he wasn't hurt," he answered to my question, indignantly.

And to top the groundless fears of any audience, the scene was shot only once. "The shooting took less than five minutes of the colt's struggles," says Mr. Bassler. "Then repeats of the film were pasted together to make the sequence." Films can fool you.

There were sixteen horses used as doubles or standins for Thunderhead alone. And what a job it was searching for albino colts and three-year-olds! But all motion picture animal stars must have their doubles. In the scene between the two stallions, which, in the picture, results in the death of one, the studios took every precaution to prevent any risks to the horses.

"Neither horse was hurt," said Mr. Bassler, "in spite of tense filming. The horses' mouths were taped to prevent biting. Their feet were shod in sponge-rubber shoes. The cameras did the rest."

What looks to be blood in a picture is nothing but red paint or wash. Lassie, the famous collie star, is adept at fooling a sympathetic audience as to her apparent injuries. In Lassie's latest film, "Son of Lassie," he (for Lassie is a male) limps heartbreakingly in a scene where he is supposed to have missed the gunfire of a brutal Nazi officer. His limps are caused by a pad on his foot, plus highly-specialized training.

Lassie is no fool. He knows he is the idol of an admiring public. He acts his part. He falls when he is supposed to die. He whines and cries on signal. He is the highest-paid, most beloved dog of the movies. He does not need Mr. Craven's intervention against possible abuse, but he does (Continued on page 330)

Peter Lawford shares top acting honors with the handsome collie, Lassie, and son, Laddie, in Metro-Goldwyn-Mayer's production of "Son of Lassie", sequel to "Lassie Come Home." Lassie, who is a male dog, is an accomplished actor who seems to realize that he has a host of fans.

Tiger on a Hill

By A COLLEGE ZOOLOGIST

(Who prefers to remain anonymous because a fox-hunt has just been organized in his neighborhood.)

Illustrated by Norman Tolson, Sr.

"ONE tiger to a hill," says an old Chinese proverb. On hills where man has not usurped the tiger's place, it is good modern ecology. Near a city, few such hills are left; but I wanted to find one.

It is hard for a zoologist to reconcile himself to urban life with bird, beast and fish almost unanimously absent, or in artificial surroundings. How can he teach ecology with only a flock of English sparrows, a pampered poodle, or a bowl of shimmering carp for object lessons? I moved to the country.

I built my house on a main highway, on a high, level site, in the midst of an oak grove. The trees are stately, but they tower over ground used for fifty years as pasture. There was not a shrub, not a low twig, to give shelter to any wild thing. Birds were few; squirrels were few. Rabbits were so conspicuously absent that they did not even nibble the young garden lettuce in springtime. Since an animal must eat about ten pounds of food for every pound of weight it gains, no predator can live without abundant prey around it, spread over a wide hunting ground. Yet it was not long before I saw my "tiger on a hill."

Away from the highroad, the house overlooked the valley of a tiny meandering stream, flowing at the base of a steep, seventy-foot bluff around the foot of a gently-sloping hill beyond. This hill, grassy on the near slope and crowned with oaks on the crest, is cut off from its surroundings by the creek on half of its perimeter, and bisected beyond by the main line of the Milwaukee railroad, which runs through a steep limestone cut in its heart. Beyond the railroad is a small woodland with a tangled undergrowth.

It was on the open crest of the hill that the "tiger" appeared, one sunny morning in early May. At first I did not recognize it. Two days before, a black dog, a brown dog, and a red dog had trooped through my domain. I remembered them because dogs are rare visitors; we keep no pets lest they frighten our birds from their seeds and suet, and the nearest farm is a quarter-mile away. While I was shaving, I kept watch out the window for passing birds. I thought I saw the red dog sitting in the sunshine on the hilltop, against the background of trees along the fence above the railroad right-of-way. As I watched, a little red squirrel seemed to scoot out from behind a tree-trunk, darted toward the dog and snuggled cosily against it. I jerked to attention and ran for my field-glasses. The Biblical day when lion and lamb shall lie down together has not yet dawned.

In the glasses appeared a bright red fox, her rich fur coat shining in the morning light, her pointed ears cocked alertly in the spring breeze. Nestling against her was a dainty fox kit, nuzzling for breakfast. Over the hilltop scampered two other frisky little forms.

I had to be off about my business, but I came home from school armed with departmental property—twelve-power field glasses, through which one could count every whisker of any fox posing in the neighborhood.

The foxes, obligingly, posed. The leaves on the trees were barely budding; there was nothing to spoil the view. Morning and evening the vixen sunned herself upon the hilltop, and not three kits, but six, gathered and gambolled on the grass about her. Whatever happened, they remained completely silent.

They never yipped or barked, either at each other or in answer to the raucous caucus of the crows, which frequently gathered near them. The babies would steal up over the edge of the hill among the trees, singly or in Indian file, venturing cautiously into view, the angle of their mother's ears indicating whether they should advance or retreat. Once out on the open grass, they played games that looked for all the world like "ring-around-a-rosy," or "fox and geese," chasing each other in an open circle, or playing hide-and-seek around the nearest tree-trunk, or wrestling like small boys in a twist-and-tumble mood. Sometimes their mother would cuff away a little fellow whose antics had made him thirsty; sometimes, with equal dignity, she would offer refreshment to the multitude. Playful, silent and serene, that happy family was the happiest sight I ever saw in Nature.

We told our city friends about it, threatening them with murder if they ever mentioned it where our country neighbors might hear, especially over our thirteen-party telephone line. Out from town they came, on foot, bicycle, and by automobile, to see what they could see. Sitting at ease on the upper deck of the house, field glasses in hand, they could watch the regular evening performance from suppertime until soft twilight blurred the outlines of the moving, furry figures. When I brought out my class of thirty girl ecology students to see the show, even their uninhibited laughter and chatter, clear and sharp across the valley in the spring air, disturbed the foxes no more than the passing of the trains as they often rumbled by.

If only friendly men could teach wild things to read! "This way to safety" would be a comforting sign when hunters are abroad. But my family could only wring their hands when they heard the sharp report of guns, and thank heaven that leaves were opening. The buds became mouse-ears as the days passed, then squirrel-ears, and, at last, the blossoms of pink and silver that oaks wear in spring. Morning and evening the foxes still played on the grassy hilltop. Day by day the grass grew taller, and the leaves gathered into a closer screen around them. We hoped their comparative safety would soon be assured.

But one day my wife saw a man walk up and over the hill. It was posted against hunters, but some hunters cannot read. Still, they can be driven off. This man could not. He was the young renter who farmed for the owner of the pasture. He was looking for two baby calves, supposedly part of the herd in the field, but vanished out of sight. My wife joined in the search, conversing volubly.

"I thought you might be a hunter, and you know we have permission to keep hunters out. I was on the warpath."

"That's all right," said the young man. "I don't blame you. When you come to the country to study wild things, of course you hate to see them killed." But he shortly remarked that in crossing the hill he had seen "what might be a skunk-den—it had feathers around the hole." The lady plunged.

"I'd better tell you we think a fox has a den there. We've seen a fox." (This was true as far as it went!) "It was a thrill to me, for I'd never seen a wild fox before. If it's eating your chickens, maybe you'll feel you have to kill it and we can understand that. But if it isn't, please don't tell anybody, will you?"

"The feathers are all brown and my chickens are all white," said the young farmer promptly, with a conspiratorial grin. "Let the other fellows find their own foxes!" (He was not his brother's chickens' keeper!) "A fox in a henroost can tear up the place in short order, but until this one tears up mine, it's safe from me."

He kept his word—or meant to. But the mother fox had heard too many human voices; seen too many people, without harm, to be properly wary. She took

to hunting in the open pasture, first near the highway, then across it. I saw her early one morning coming through the undisturbed cattle toward our house. She leaped through the pasture fence into our yard, passed directly below my bedroom window with a mouse tail dangling from her mouth, and eased gracefully through the fence along the bluff, disappearing over its edge. We never saw her, or her kits, again.

While we were still spending all our spare time eyeing the hill for a sight of the foxes, a distinguished visitor joined our watch. She was Mrs. Ballington Booth of New York City, head of the Volunteers of America, and an ardent Nature lover. The idea of seeing our foxes appealed to her. "I have never seen a fox in the wild but once," she said.

"When I was only four years old, I had an adventure with a fox which made a deep impression on me. Fox hunting in England, of course, is very popular, and there was a hunt near Limpsfield, where we lived, of which a cousin of ours was 'Master.' We children called him 'Cousin Red-Coat.' One day there was to be a hunt, and all the hunters were invited to lunch with our family at the rectory. About noon, my sister Florrie and I went out to watch for them. Florrie was then six years old (years later, as Florence Barclay, she wrote *The Rosary*, and several other novels popular both in England and America). We stationed ourselves under a cedar tree in the garden, in our best white dresses and blue shoes.

"We could hear the baying of the dogs in the distance, drawing closer. Then, leaping over a fence into a nearby field, running toward us, we saw the poor fox. It took to the little stream below the rectory garden, then came up the slope. It was panting so hard we could see its sides working in and out. Saliva was dripping down at the corners of its mouth. Its tongue was hanging out and it could hardly draw breath. It streaked straight past us, and into the open door of a little building in the garden where the serving 'boy in buttons' cleaned the boots.

"Quick as a flash Florrie and I ran and slammed the door, locked the fox inside, and threw the key into the rose garden. Then we took our places demurely under the cedar tree again, and watched the huntsmen, just coming into sight. They looked magnificent in their red coats and on their handsome horses. They poured over the fence on the other side of the stream, but the fox had taken to the water at the foot of the garden, the dogs temporarily lost his trail, and, in any case, the riders could not follow it through my mother's flower beds. They dismounted and came to lunch.

"We children were taken in to be introduced to the gentlemen, and I was so disgusted because Cousin Red Coat insisted on kissing me, when I was angry at him for hunting the poor little fox, that I crawled under the lunch table. I was hauled out and sent away in disgrace. But as soon as the hunters had mounted and ridden away, Florrie and I slipped into the garden, rescued the key from the rosebushes, and threw open the door. The fox stared at us, frightened, not knowing what was going to happen. Then suddenly it was off like a shot and disappeared. We never dared tell our parents about it, but we always remembered."

The young farmer told us later why our watch was in vain. "I shot that fox. I was out plowing" (on his own side of the highway, not the fox's) "and it came trotting by from the direction of our henhouse with something in its mouth. I thought it had a chicken and went and got my gun. The fox was still there—too tame for its own good. I hit it; it fell down. But it dropped what it was carrying and tried to pick it up. I shot again, knocked it over, but it ran away. Then I picked up what it dropped and found it was a fat mouse. I felt kind of bad about it."

We felt worse than "kind of" bad, as we watched the green, bare hilltop day after day. We feared that the mother had died of her wounds, leaving the kits too young to hunt for themselves. But one summer night we heard a bark that no dog ever uttered. "It was a fox!" we exulted. "At least one must be alive!" But we watched in vain for any sign of it.

The day that the first deep snow of winter fell, we saw something moving among the white flakes. The shape settled on the lee side of a big tree, and rested in lazy grace. In the dull light it was not red, but warm, tawny brown. It had pointed ears and nose, and fine bushy tail. Once more our hill had a tiger.

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Summer

By LALIA MITCHELL THORNTON

Summer is always planning some surprise,
Fledglings, and golden rod, and dragon flies,
The gray cocoon from which a moth is born,
A puff of ergot, on a shaft of corn.
A briar thicket turned into a house
Safe sheltering a brood of wary grouse;
Small minnows in a shallow land-locked brook,
And lichens, never pictured in a book.
Beyond the limits of my open door
Summer has always something new in store.

The Magnificent Quetzal

This avian emblem of Guatemala is one of the world's most beautiful birds

By ALEXANDER F. SKUTCH

AMONG the birds of the Western Hemisphere, the quetzal occupies a unique position in legend, symbolism and popular interest. It ranks among the half-dozen or so most beautiful birds of the Americas, and some would place it first even in this select group. Before the Spanish Conquest, the long, slender, green plumes of the male bird's train adorned the headgear of Aztec and Mayan kings and chieftains, as one may clearly see in modern restorations of ancient scenes. Emblem of the Republic of Guatemala, the quetzal is one of the few birds that has won a place upon a national coat of arms by virtue of beauty rather than of size or predatory fierceness. Yet through the centuries the quetzal, finding only in remote mountain fastnesses protection from the unremitting persecution of man, has remained a bird of mystery.

My study of the home life of the quetzal, in the storm-beaten Costa Rican mountains where it nests, was the culmination of two decades of growing interest in this regal bird and its relatives. My awareness of its existence began when, as a schoolboy, I proudly added to my collection a highly colored Guatemalan postage stamp depicting a glittering green bird with a crimson abdomen, a narrow, ridged crest extending from its bill to the back of its head, and two slender, gracefully curving plumes that formed a train longer than the bird's body. Later, the college professor of zoölogy, addressing our naturalists' society, exhibited a mounted quetzal—a bird scarcely larger in body than a carrier pigeon—and explained that these splendid plumes were not the tail proper, but abnormally elongated feathers of the upper coverts, and that the female was far more plainly attired. He told us that the quetzal belonged to the trogon family, a magnificent group of birds found in the Tropics of both hemispheres, but most numerous in the New World, where one exceptional species ranges as far north as southern Arizona. He briefly related the little that was then known about the quetzal's habits.

Years afterward, I made several long visits to Guatemala, where I found this bird much in evidence. Its gracefully conventionalized figure appeared in the coat of arms on the walls of most of the public buildings, and on the medallion in the center of the blue-

At the border of the subtropical forest, near the headwaters of the River Sarapiqui in Costa Rica. Here the author sought out the haunts of the quetzal, and lived there a year to study its habits. This was a spot slightly more than a mile above sea level, a region swept by rain-laden winds and often shrouded in heavy mists.

and-white banner. As a traveller, I found it necessary to keep my pockets well filled with *quetzales*, which also seemed to have wings and fly as I paid hotel bills, railroad fares and Indian porters; for Guatemala has named its monetary unit for the national bird, as other Spanish-American countries have bestowed this questionable honor upon famous men. I learned that the name of the second city of the Republic, quaint, cold Quezaltenango, means "place of Quetzals"; but I looked in vain for the bird among the low, second-growth woods of oak and pine in the vicinity of the highland metropolis of western Guatemala. Stuffed specimens of the quetzal were shockingly abundant in shop windows and private homes, but mostly they were frowsy examples of taxidermy. No poor stuffed effigy with ghastly eyes of glass, nor any picture I have ever seen, conveys a just conception of the superb beauty of the living quetzal.

A nestling quetzal twenty-one days old and seemingly without much promise of its future beauty.

The great abundance of these lifeless travesties of the quetzal made it clear why I so seldom saw living birds in the forests. The Indians, while they ruled the land, snared the birds alive, removed their long ornamental plumes, then released them to grow these feathers anew, thereby providing for a continuous supply. Less foresighted, the white conquerors of the country permitted the unlimited slaughter of the quetzals, with the result that they soon vanished from the more accessible regions. Although described by some of the early Spanish historians of the New World, the quetzal was, as late as the 18th Century, so little known in Europe that some of the more cautious naturalists listed it with the phoenix and the roc among the birds of fable. It was not until 1832 that the French ornithologist De la Llave formally described the species under the name *Pharomachrus mocinno*. Soon countless thousands of these glittering creatures were sent across the Atlantic for the plume trade and the cabinets of collectors. Most of them were slaughtered in the Guatemalan Department of Alta Vera Paz. It was not until the early 1930's, when they already seemed in danger of extermination in Guatemala, that an earnest effort was made to protect them in that country. Now that General Ubico, fallen from power, is vituperated by his political adversaries, let us not forget that among other claims to the gratitude of the country he governed for so long was his attempt to save the quetzal.

During my years in Guatemala, not only did I see much of the quetzal—in its conventionalized or desiccated form, if not flying through its native forests —but I heard a good deal about it as well. Guatemalans were proud of their national bird, and eager to point out to the stranger those lofty qualities that made it the fit symbol of their aspirations. Its noble spirit would not submit to captivity; if placed in a cage it would refuse all food and die. I have heard of quetzals from Honduras and Costa Rica, taken as nestlings and reared by hand, that survived long periods in a cage; but I sincerely hope that none hatched on Guatemalan soil have so lamentably betrayed the Republic's ideals.

On every hand I was told, too, that the hole in a decaying trunk in which the quetzal nests is provided with two doorways, situated on opposite sides, so that the male, when he came to take his daily turn at incubation, could enter by one and leave through the other, thereby avoiding the necessity to turn around in the confined space, bending and damaging the long plumes of his train. But none of my informants claimed to have seen a quetzal's nest with his own eyes. Searching through the books on Central American birds, the only scientifically competent record of the quetzal's nest that I could find was one published as long ago as 1861 by Osbert Salvin, the Englishman who deserves the title "Father of Guatemalan Ornithology." In the mountains of Vera Paz, his Indian hunters showed him a quetzal's nest, situated in what he supposed to be an old woodpecker's hole, which had but a single doorway. Because in those days most ornithologists were too eager to shoot the birds to learn much about their habits, he carried away the impression that incubation was performed by the female alone.

The geographic range of the quetzal extends from the Mexican state of Chiapas to western Panamá. Like nearly all birds of tropical regions, it is not uniformly distributed throughout its range, but is re-

stricted to a definite altitudinal belt. In Guatemala it inhabits the zone between about 4000 and 7000 feet above sea-level, while in Costa Rica, nearer the equator, it dwells somewhat higher. Even within these vertical limits, it is confined to districts where there are considerable areas of the heavy rain-forest in which it finds food, nest-sites, and protection from the persecution of man.

On my early visits to Central America, I studied the birds in regions too low for the quetzal, or, during one year, on mountains too high for it. Yet year after year I learned something more about the ways of the trogons, that glorious family of which the quetzal is the most distinguished member. I found them nesting in the most surprisingly varied situations: in cavities in rotting trunks; in dark chambers that they carved deep into the big, hard, blackish, arboreal nests of termites; and even in large, papery wasps' nests attached to lofty branches. With all these trogons, so far as I could learn, the male bird took a large share in carving out the nest-chamber, and aided in the incubation of the two or three white or bluish eggs, often sitting with admirable patience through half the day in one continuous session. These trogons' nests, in whatever medium, had but a single doorway. None of the male trogons that incubated in them, however, bore the long train and other ornamental plumes of the male quetzal. Did this bird share in the duties of the nest like his less elaborately attired cousins, or had his more gorgeous regalia led to an aloofness from domestic affairs? And if he did indeed sit in the nest, was this provided with a second doorway for the better preservation of his plumes? These were questions that recurred to me again and again as I continued my studies of the trogons.

A female quetzal at the nest and about to deliver a golden beetle or other insect to the nestlings.

I had already spent nearly four years in Central America before I saw my first living quetzal. In company with a young student from the agricultural college in Guatemala City, who was going to spend his vacation with a brother on an isolated farm in the northern part of the Department of El Quiché, I made a long horseback journey through the wild, forested mountains lying north of the Sierra Cuchumatanes. As we rode along a narrow trail winding down a precipitous mountainside, my companion was telling me how on an earlier journey he had seen a quetzal on this same descent. This information caused me to look sharply among the tree-tops. Before long, a splendid male quetzal darted forth from one of the great trees that towered above us and winged across the deep ravine to our right. His flight, like that of other trogons, was somewhat undulatory; and the long, slender feathers of his train, carrying out the rhythm of his movement, rippled gracefully like long ribbons trailing behind him. Before I had time to recover from the surprise and delight of this sudden meeting, a second male quetzal, equally magnificent, followed after the first. Instead of disappearing at once into the forest on the far side of the ravine, this one came to rest for a few seconds on an exposed bough, where I enjoyed a fleeting glimpse of him through my field glasses. What a glorious sight he made! This meeting with the quetzals was the most memorable incident of the entire two-weeks journey.

Finally, I determined to spend a year in the haunts of the quetzal, and make an intimate study of its habits. I was now living in Costa Rica, and in July, 1937, found a suitable lodging on the northern slopes of the Cordillera Central, between the volcanoes Barba and Poás, at an altitude of a little more than a mile above the Caribbean Sea, which from my dwelling I could see far in the northeast, over a vast extent of almost unbroken forest. The woods close about the little cottage were dominated by trees well over a hundred feet in height, whose lofty branches bore up huge quantities of air-plants, ranging in size from mosses and diminutive ferns to bushes and even large epiphytic trees. A profusion of orchids of all sizes and colors, handsome flowering shrubs, stately tree ferns and palms, with bright meadow flowers in the clearings, made this a region of unimaginable beauty. But the climate was a sore

A clearing in the forest near Vara Blanca, Costa Rica, where the author carried on his study of the quetzal. A pair of the birds nested at the edge of the forest at the lower end of this clearing.

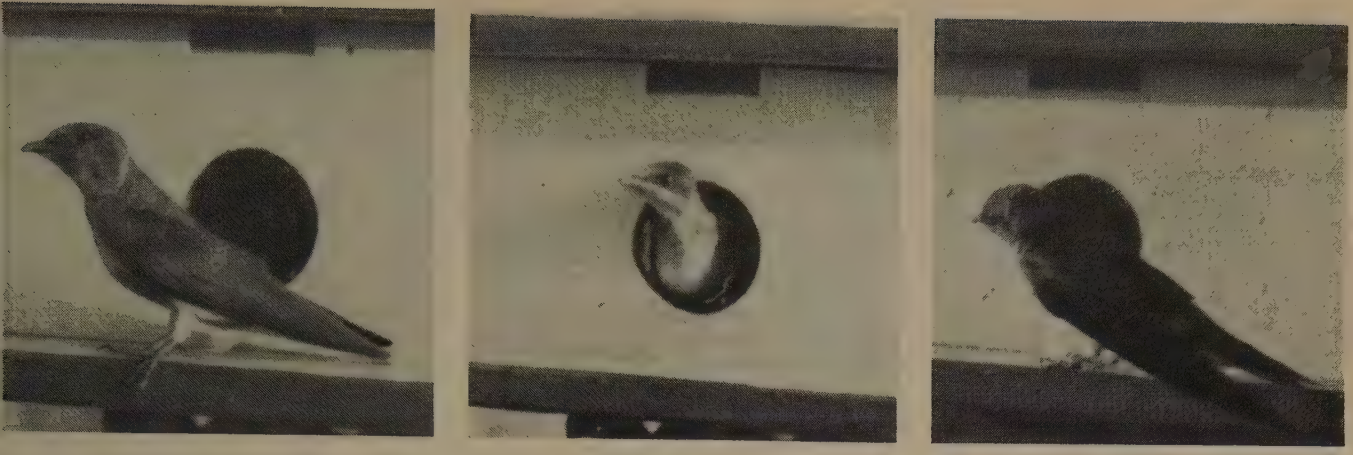
trial. For weeks together, the winds sweeping over the Caribbean and the great forested plains to the northeast would drive the rain-laden clouds against this exposed mountainside. Day after day I lived enveloped in gray mist, until the sun became but a distant memory, and the moisture-laden air chilled me to the marrow. During the stormy months of the northern winter, it was hard to persevere in my resolution to pass a year in these cool, damp, mist-shrouded haunts of the quetzal. These birds now seemed so rare in the vicinity that, in the fits of gloom that would come over me after many days of solitude and rain, I would despair of ever finding their nests.

But toward the end of February, when the weather was somewhat drier, I began to hear the mating calls of the quetzals floating up from the surrounding forests. During March these calls grew more frequent, and it became clear that quetzals were quite abundant in the neighborhood. They were beautiful notes, soft and mellow, yet full, deep and powerful, in character somewhat like the calls of some of the smaller trogons, yet surpassing these in strength and beauty, even as the quetzal excels his smaller relatives in splendor of plumage. Other utterances of the quetzals were of a very different nature. There was a loud, startled-sounding *wac-wac, wac-wac,* often voiced in flight, not merely during the breeding season, but throughout the year. Rarely, at the height of the nesting period, I heard a high, soprano, sliding *whooo*—a surprising performance that at first I was inclined to attribute to a mammal rather than a bird.

Early in April my dream of years came true—I found my first quetzal's nest. During the following weeks I discovered three more occupied nests and two others that had been recently abandoned. All were situated in decaying trunks standing in the forest or in shady pastures not far from its edge. In height they ranged from fourteen to about sixty feet above the ground. In form they resembled the nest-cavity of a woodpecker; but if originally made by woodpeckers, they had at least been considerably enlarged by the quetzals, for no woodpecker at this altitude is big enough to require so capacious a hole. At the top of each cavity was a single, roughly circular doorway, about four inches in diameter. One nest-chamber extended eleven inches below the entrance and was about six inches wide. A single nest, which I did not see until after some predatory creature had broken the eggs, was more shallow than the others and appeared to have been freshly carved. The man who showed it to me said that he had seen the male and female quetzals take turns at digging into the wood—which is the way other kinds of trogons make their nest-cavities. The other nests were in holes that seemed to have been dug out the preceding year, if not earlier. Some were in wood that had already reached the last stages of decay. Because of the danger of climbing up to them, I waited until the nestlings had flown, then pulled over two of the trunks, hoping to examine the nest-cavities. But upon striking the ground, these trunks crumbled into formless heaps of rotten wood, in which no trace of the chamber remained. No woodpecker that I know would nest in wood that was so far advanced in decay.

The quetzal's two light blue eggs rested upon fragments of wood at the bottom of the cavity, for no softer lining was taken in. The male took an important share in incubation. It was easy to see, even from a distance, that he was in the nest; for the terminal eight or ten inches of the long plumes of his train projected through the doorway and waved gracefully in the passing breezes. Apparently he sat in the chamber like other trogons, facing forward, with his tail (which is of ordinary length) held upright against the rear wall, and the long, elastic plumes of the upper tail coverts bent forward at the top of the cavity, passing above his back and head and continuing through the entrance-way, against whose upper edge they pressed. The Guatemalan story of the two doorways proved to be only a myth, although based, perhaps, upon some exceptional nest, which, through the falling away of part of the crumbling wall, did have two apertures by chance rather than design.

Long-continued vigils at several nests showed that the female quetzal occupied the hole through the night and during the middle of the day, while the male took a long spell on the eggs each morning and afternoon. Together, his (Continued on page 330)



At the martin house. Left, a male bird and, right, a female. In the center a young martin surveys the landscape. Young martins usually fly before they are fully feathered.

Mite-y Troubles Among the Martins

By J. FRANK BERRY

IN OUR yard is a twenty-five-room martin house. Like most martin houses in this Iowa locality, it is placed on a high pole, and, each summer, is popular with families of purple martins. But every year its tenants are made miserable by the presence of mites, perhaps brought by English sparrows, which often nest in the vacant rooms of the martin house. However, we have been quite successful in helping the martin to combat the pests, and our experience may help others to save more of their young birds.

The mites make life particularly difficult for the young martins. They gather mostly on the head of the bird, sometimes becoming so thick that the head can hardly be seen. When this happens, death is almost certain for the luckless victim. From sheer misery, the young bird will leave the nest, jumping or fluttering to the ground. Then, if it survives the long fall, it is likely to become a choice meal for some neighbor's cat. If man comes to the rescue soon enough, and finds the baby before the cat arrives, it has a chance.

We try to keep a rather close watch on the ground around the martin house after the young ones begin to hatch. Whenever we find one, we take a package of good insect powder, containing a good proportion of pyrethrum, hold the bird in one hand, and dust it with the powder. Insect powder in the little bellows type of box is most convenient to use. After the young martin has received several of these treatments, the mites will be gone.

Recently a reader in Indiana wrote for advice, saying that his young purple martins were falling from the nests. We had Mr. Berry's article in the files, and, in the hope it may help others, publish it here.

Young martin raised by hand. It had been injured falling from the nest. Although in full feather, it could not fly.

Then there is a new problem to consider, for no matter how many times the baby is replaced in the nest, it will not stay. It is almost always impossible to get a young bird to stay in the nest after it has once left.

In playing nursemaid to these young birds, we use an old table about three feet square and with a rim around it. On the table we keep a small box in which the babies may hide. Without this hiding place they will not stay. We also keep water on the table, although it probably is not necessary. At night we take the babies inside to protect them from cats, and from the cold night air.

It is seldom necessary to feed these birds, as the old martins will care for them on the table, just as they do in the nest. Occasionally, one seems to be an outcast, and the old birds will not feed it. Then it becomes necessary to feed the baby by hand. The best food that we have found to use in hand-feeding is grasshoppers. They are easy to get, and the birds do well on them. If one fears that the old

A group of young martins that had fallen from the nest when beset by mites, and had been raised by hand or fed by the parents on a table specially supplied for them. The young birds, although freed of the mite pests, would not remain in the nest no matter how many times they were returned there. Hence a substitute had to be provided.

birds are not feeding the young, he need only offer them food. When the old ones are feeding them, they will refuse other food that may be offered to them by helpful humans.

Most of our bird pictures are snapped by my wife from a kitchen window that gives a good view of the yard. I make the set for the picture, string the wire through the window to a set of batteries. All that has to be done to take the picture is to press a button connected with the home-made electric trip on the shutter. Sometimes the camera must be set for a rather long time to get one picture. It required two days to get a picture of the camera-shy male martin. Some birds pay no attention to the presence of the camera, while others will almost starve their young before they will come within the three-foot range.

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Growing Cattail Gayfeather

By EDWIN F. STEFFEK

THE cattail gayfeather, *Liatris pycnostachya,* is an unusual and easily-grown native plant. It readily makes itself at home in the garden as well as in wild surroundings, and is one of the best for the beginner in wild-flower culture.

This plant is a native of the prairies and is found from Indiana west to Minnesota and Nebraska, and south to Arkansas and parts of Texas. It grows to a height of three to four feet and produces its pinkish-lavender, thistle-like flowers in graceful spikes during August. Not only does it have a strong attraction for butterflies, but, unlike almost every other plant, it blooms from the top of the spike down and is, therefore, especially interesting. The leaves are narrow and closely-set.

The cattail gayfeather is not fussy but does best in a light, fairly rich but well-drained soil. It readily makes itself at home in full sun or light shade. Owing to its color, it is especially effective when combined with the yellow of goldenrod or other flowers.

Propagation is comparatively easy. Seed may be sown, either in boxes or outdoors, as soon as ripe, or held as long as two to three years, if kept in a cool, dry place. The seeds usually germinate the first spring, and will often produce blooming plants by the second year.

The plants may also be divided in the spring. Basal leaves have even been rooted after treating with some of the root-inducing preparations.

Some Common Mushrooms

PINE CONE MUSHROOM

This is the thirty-fifth in Nature Magazine's series of educational inserts.

By E. LAURENCE PALMER

DURING my student days in college, I was more or less surrounded by men and women who spent most of their spare time in the summer and fall months in the fields, a basket on one arm and a roll of paper in the other hand. While I was collecting seeds, they were collecting mushrooms. When they found one, they knelt down, picked it, and gently wrapped it in paper. A collection complete, they hurried back to the laboratory to photograph, describe or dry their findings. They were fully as enthusiastic about these beautiful fungi as was my German professor about his mosses, my wife about her fossils, or others about their birds, snakes, ferns, irises, roses, postage stamps, old buttons, old glass, iron grills, china or sea shells.

In spite of the fact that I was associated for years with these able naturalists, and "took" a number of courses on the fungi under that master mycologist George F. Atkinson, I never could myself go "all out" for the fungi the way I could for many other things in Nature. That does not mean that I do not recognize their varied appeal. They offer profitable occupation for many people. They are potentially more valuable than they now are practically. At the same time, they are potentially more destructive of many of our biological assets. A mass of sulphur polypores extending in a confusing mass of shelves from an oak tree must offer highly varying appeals to the forester, the cook, the artist, the scholar, and the amateur collector. Any series, such as this of which these eight pages are a part, must give these plants consideration. So here we are.

The greatest danger in writing an article of this sort is that some may assume that a fungus they find looks enough like one figured and described here to satisfy them as to its identity. Yet it may have minor differences that are important, and it may really be a dangerous species. The best advice to beginners, then, is to learn to know a few mushrooms well, and stick to those known to be safe when planning to use them for food.

One of the most recent popular books on edible mushrooms recommends four that are considered foolproof, but it would seem that this number could be safely enlarged. Certainly, anyone wishing to make a list of safe mushrooms would include only those whose dangerous relatives can be easily identified, those of which there is likely to be an abundant supply generally available, and those that are edible in the best sense of the word.

MOREL

Any list of safe mushrooms would, of course, include the morels, or sponge mushrooms. Sometimes, they are tremendously abundant and they are always delicious. I remember collecting nearly a bushel of these on a trip with my botany class in Iowa, coming back to the laboratory, raiding a nearby home economics kitchen for some butter and enjoying a feast that still stands out with me as a high spot in mushroom sprees. Never since have I ever seen or eaten so many morels at one time, and never until now have I admitted where I got butter at a time when all the stores were closed.

So delicious are morels that it is surprising that their culture has not been undertaken seriously. They grow in good clean woodlands rather than in manured pastures or cellars, and they have a pleasant flavor and a firmness that makes one enjoy biting into them. True, they sometimes harbor little animals in their hollow interiors, but, if the morels are split and washed before being cooked, all of these potential side dishes may be avoided. In common with some other delicious mushrooms, however, they can not always be found in abundance at a given place, year after year. In contrast, I know a stump in the woods, two hundred yards from where I type this, that each year produces in abundance a mushroom that is perfectly safe and good to eat even though it is tougher than field mushrooms or the morels. Sometimes, I wonder if it might not taste much better if it were as elusive as are the morels. Perhaps a part of the joy of eating morels comes from finding them, just as the flavor of trout seems to be improved by catching them yourself.

HONEY MUSHROOM

INKY-CAP

Another perfectly safe group of fungi to use is the puffballs, if one merely remembers to eat only those with solid white centers. That rule is so simple that anyone can apply it safely, and the shape of the puffballs is such that the only possible confusion might arise by collecting

FAIRY-RING MUSHROOM

PUNGENT RUSSULA

CHANTERELLE

OYSTER MUSHROOM

MILKY-CAP MUSHROOM

HEDGEHOG MUSHROOM

FLY AMANITA

some poisonous gill fungus in its initial stages. If one remembers to cut the balls in two, the gills will show in the balls, and so there need be no danger of confusion.

Scarcely a year passes but someone calls me up and asks if it is safe to eat a big white puffball that is a foot in diameter. Frequently, I am tempted to suggest that it would be better if they sent it over to me for identification, thinking that maybe in that way I might get a few slices for myself, but I restrain myself. Usually, I try by phone to let them know how much I like these big puffballs, but to date no one has taken the hint. Instead, they have told me some time later how delicious they were, and how they really had more than they could eat. I remember one of these huge puffballs — collected on a field trip with a class—that provided a good helping for each member of a group of twenty. But, although I have camped for years at the same spot at the corresponding week in the summer, never but that once have I found one of these huge balls there. If one could control this vagary, and could harvest regularly cultivated puffballs as large as the largest produced by Nature, he would have something. The only difficulty with them is that they do not stand shipping and storing as do commercial mushrooms. Instead of drying gracefully, they go all to pieces.

If you will read the chart section on puffballs, you will find an excellent opportunity for your imagination to run wild. You might make a wild estimate as to the potential volume of the second generation of the largest recorded puffball, assuming that each spore produced a puffball the size of the largest. People have let their imaginations run wild along other lines, however, and we have folk lore contending that a cut, mature puffball applied to a cut finger will stop the flow of blood, while still other legends tell us that the spores are dangerous. We have the tale that meteors falling to the ground become "earth-stars." An earth-star is, of course, a sort of puffball.

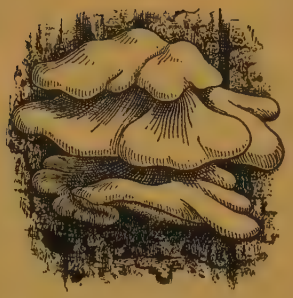
Possibly the most delicate of the mushrooms that are safe and abundant are the shaggy-manes, inky-caps and their ilk. These are the compact little mushrooms that appear all summer, springing frequently from the place where an old tree had lived. There are two excellent patches of these mushrooms growing on lawns between my home and my office. Each year we get at least one good crop from them. I admit that I always feel a bit sheepish collecting these from in front of a home whose owner I do not even know, but, after seeing one crop of the delicious things go to waste without their being harvested, one somehow feels as though it were only fair that he make the most of an opportunity. Consequently, I provide myself with a good big paper sack on the proper day, make it a point to go early or come home very late so I can slip in, fill the bag and be on my way, safe in the thought that, even if I were seen, I would not be recognized. Of course, one could go up to the house and ask permission to make the harvest, but the value of the fungi might then become so appreciated that I would never again have the chance to make a harvest.

These fungi of the genus *Coprinus* are all characterized by the fact that, when mature, their gills "melt" down into an inky mass. When young, the fruit bodies are usually cone-shaped, with exceptionally fine gills crowded closely together and usually showing a silvery appearance over the gill surface. These mushrooms could never be a commercial success since they spoil within a few hours. But, if they are collected in their prime, parboiled briefly in a strong salt solution, and then fried quickly in hot butter, they are hard to beat. Frequently, they break down badly in the cooking process, but, where this occurs, one need merely change plan and decide that mushroom soup was what was intended. *Coprinus* soup is a delicious dish to drink, even though it may look a bit like hot ink. One nice thing about these mushrooms is that they persist in coming up in the same spot through a long summer season, and year after year. Usually, the inky-caps are sufficiently abundant to provide a meal for the whole family without the necessity of

COMMON MUSHROOM

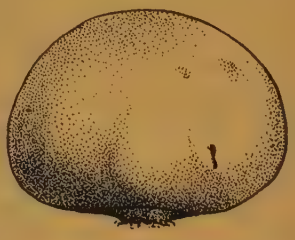
CORAL OR CORAL FUNGUS

VELVET-STEMMED COLLYBIA



SULPHUR SHELF MUSHROOM

EARLY PHOLIOTA



PUFFBALL

JACK-O'-LANTERN

running all over the county to get what is wanted. Shaggy-manes are more likely to be found growing in small clumps, or alone, and while they are much larger than the inky-caps, it usually requires much more exercise to collect a satisfactory mess.

We have been told that sometimes firms, desiring to give to their inks a microscopic quality that may be used in identifying signatures, make a practice of mixing the ink of these inky-caps into their commercial ink. The spores, persisting, may be identified microscopically in the signature if there is any reason why such signature is needed to be microscopically distinctive.

The polypores are generally safe for anyone who might wish to eat them. They are easily identified by the finely punctured undersurface from which are shed thousands of spores. Most of those that we find as shelves on tree trunks are too tough to have culinary value but, when young, many of these have good possibilities. The sulphur polypore is probably the most popular of all of these, unless it might be the beef-steak mushroom, which, in texture and color, if not in taste, resembles one of those toothsome decorations that used to adorn dinner plates in the days before rationing took over.

Some of the fungi whose spore-bearing surface is marked by many pores have the form of the ordinary mushroom. Members of the genera *Boletus, Boletinus* and *Strobilomyces,* for example, have many species of which the more dangerous ones are usually unpleasant to the taste and smell so badly that they would not be eaten anyway. Since these rarely occur in great numbers, and since some are suspected of being dangerous, it might be better to leave them all alone unless you become a specialist. However, you probably need not get worried if one does happen to be eaten.

All this brings us up to the point of trying to see if there is any rule one may apply to help one know when a mushroom is safe to eat. I well remember an uncle of mine—a high school principal—telling me something about peeling the tops to find out whether the species was safe, but whether he said it was safe if it did peel, or was not safe, I cannot recall. Anyway it makes no difference, because no such rule is valid. Neither is it safe to say that if the mushrooms stain a silver spoon when being cooked they should be discarded as being dangerous. And there are no valid rules based on bitterness, color, juice color, odor, taste or color change.

George F. Atkinson, who tried to teach me more about mushrooms than I then absorbed, used to tell of his technique for learning whether a mushroom was safe or not. He would take the tiniest nibble of a given mushroom, and if in a day or so he felt no ill effects, he might try taking a still larger bite. Continuing this technique of making a guinea pig of himself, he eventually came to the conclusion that a given mushroom was good or bad. Frankly, I cannot enthuse over this system sufficiently to apply it personally, particularly when there are enough mushrooms of known virtue to satisfy most of my rather generous wants in this direction.

The nature of the poisonous substances in some mushrooms is such that ill effects should not be expected immediately. While most of them will begin to make themselves felt within six or seven hours, with others it may be as much as two days later before the symptoms appear. So virulent are the poisons in some of the bad mushrooms that a single forkful may be sufficient to cause death. Thus it is not smart to take any chances with them, nor should one for a minute rely on the judgment of amateurs who may have made collections in the wild. The safest thing is to stick to a few species you know, or to depend on commercially grown mushrooms purchased through some reliable dealer. Do not risk your own life and the lives of some members of the family by making a purchase from some backdoor peddler who assures you that he knows all about his wares.

Of course, there are always individual differences in the effect mushrooms have on us. (Continued on page 312)

COMMON NAME SCIENTIFIC NAME	MOREL. SPONGE MUSHROOM *Morchella* sp.	CLUB OR CORAL MUSHROOM *Clavaria formosa*	HEDGEHOG MUSHROOM *Hydnum coralloides*	SULPHUR SHELF MUSHROOM *Polyporus sulphureus*
DESCRIPTION	Erect fruit body; to 6 inches tall, with cap occupying from ½ to 2/3 upper portion, and being rather deeply and irregularly impressed with dark areas separated by lighter areas; stem and cap-portion hollow, somewhat yellow-flesh-colored, brittle and tender but moist. Stem does not continue deep into ground as such.	Upright, repeatedly branching, with branch tips always pointing upwards in contrast with downward pointing teeth of hedgehog fungus. *C. formosa* is to 8 inches high, with stout stem to an inch through extending deep into ground, brittle, brightly pink, red or orange when young, but yellow to brown when old.	A profusely, irregularly branched, hemispherical mass to one foot across, of pure white fungus material bearing from beneath the branches downward-hanging teeth to ¼ inch long; a single fruit body often weighs to over one pound. Whole mass arises from a common stem. Teeth cover all of under surface.	Fruit body appears as bright red shelf or series of shelves, the lower of which are usually larger with undersurfaces crowded with round pores. Older shelves show radiating furrows and ridges that create a fan-like effect for whole fruiting body, and in the older shelf the rim is thin.
CLASSIFICATION AND RANGE	Order Helvellales. Family Helvellaceae. Ordinarily classed with Ascomycetes, but by some placed in separate group, Discomycetes, including some other cup fungi in all of which spores are borne in sacs lying closely crowded on fruiting surface. Morels are woodland species found over most of United States and in Europe. Frequently most abundant in woodlands recently burned over although not limited to such areas. Fire may not be important factor in abundance.	Order Agaricales. Family Clavariaceae. Fruiting Clavariaceae are practically all erect or sprawling, but upward pointing at tips with branches usually flattened. Coral fungus, a species of *Hydnum*, should not be confused with coral fungi, a general name for Clavariaceae. In Hydnaceae, fruiting tips point downward; in Clavariaceae, upward. *C. stricta* and *C. formosa* represent crowded, branched forms; *C. pistillaris* a solitary type. Widely distributed in North Temperate Zone.	Order Agaricales. Family Hydnaceae. Fruiting surface covered with downward pointing teeth, spines, warts or sometimes interrupted folds. Bear's head fungus, closely related, has teeth to 4 inches long and *H. repandum* has teeth beneath white, buff or yellow cap, supported by coarse stem. Coral fungus widely distributed through United States in woodlands. *H. putidum* has coarse, spongy stem; when fresh, smells like perspiring human.	Order Agaricales. Family Polyporaceae. Family includes a variety of forms, some umbrella-like as in *Strobilomyces* and *Boletus*, and many shelf-like or even plate-like, but all marked by crowded pores on undersurface of the fruiting body. Related beefsteak mushroom, *Fistulina hepatica*, has soft, fleshy shelf that is juicy and blood-red when young, but tough and hard when old. Other genera and species in family are always hard or woody.
REPRODUCTION	Spores: shed from hollows in upper part of fruiting body, usually during damp or rainy weather. Different species vary in shape of fruiting body and in nature of pits near top. Related *Gyromitra* seems to be a many-capped morel; not edible.	Spores borne all over the upper surface of branches, in *C. formosa* being light yellow in mass and probably being responsible for the color of that part of the fruiting body that bears them. Spores may be carried by insects attracted to the colored areas, some of the spores being minutely spiny.	Spores of hedgehog fungi, borne on downward pointing teeth, freed from them and carried to new food supply in which they germinate, develop a tissue-destroying plant-body from which they eventually bear new fruiting bodies, usually in late summer.	Spores shed from downward pointing pores, new layers of which may be formed in succeeding years in suitable weather conditions at 4.5 million per square inch per hour or 375 million a week. Wood rotted by fungus resembles red-brown charcoal, with concentric and radial cracks filled with large sheets of fungus.
HABITAT	Found in wet woodlands usually from May to June but highly variable in different years, so that a place that may yield many in one year may have none the next. The conditions under which they thrive apparently cannot be duplicated to permit raising commercially.	Many clavarias seem to grow merely from the ground in wooded areas though some grow directly from rotting wood; some bear fruiting bodies at any time of the year and some are tough, while others are soft and watery. Few, if any, have fruiting bodies buried in forest floor.	Coral fungus found only on decaying hardwood, while bear's head may be found on living or dead hardwoods; therefore fruiting bodies may be found more than one year on the same source. Other coral fungi may live on rather well-rotted woody plant tissue.	Lives on woody plants that are alive or dead, favoring cone-bearers, oak, cherry, maple, chestnut, butternut, walnut, alder, locust, apple, pear, but also found on other trees. It fruits in fall when summer droughts have passed, and appears year after year on same logs.
RELATION TO MAN	Morels possibly excel all other fungi in food value and since all are edible and most are delicious, they are popular with amateurs. Insects sometimes are found inside, but, cut open, washed and fried in butter, morels are hard to beat as a table delicacy.	Probably no clavarias are poisonous and while many are edible, few are delicious. Greatest weakness seems to be that of being too tough; some have a disagreeable flavor but others have little distinctive taste. Should be cooked slowly, then fried in butter, to taste like noodles.	Coral fungus and bear's head fungus are edible. *H. repandum* considered one of best of table mushrooms. Single fruiting head of coral fungus may be a meal for a family. Coral fungus may appear "flat" and tough, but is remarkably free from insect pests. Sometimes bitter, but not if just boiled, then stewed slowly.	Fruiting shelves cannot be confused with any poisonous mushroom and if collected young, parboiled in salt water and fried in butter, have a delicious taste. Older shelves are tough. The plant is, of course, a pest to trees, and it may be desirable to burn infected logs to protect healthy trees.

PINE-CONE MUSHROOM *Strobilomyces strobilaceus*	SHAGGY-MANES AND INKY-CAPS *Coprinus* sp.	COMMON OR FIELD MUSHROOM *Agaricus* or *Psalliota campestris*	EARLY PHOLIOTA *Pholiota praecox*	FLY AMANITA *Amanita muscaria*
Fruiting body: like coarse umbrella, with cap to 4 inches across, soft, spongy, with surface covered with coarse, hairy, upright, blackish brown scales, with margin scale-fringed; under surface crowded, with pores that are white at first but change to black when wounded and have angular openings. Stem: to 5 inches long and to ¾ inch thick, brittle.	Fruiting bodies to 20 inches tall but usually under 6 inches. In general, rather cylindrical, with cap expanding upper portion. Delicate, with gills fine, closely crowded, and in age breaking down to make an inky mass. In shaggy mane, *C. comatus*, the outer part of cap is shaggy and in inky cap, *C. atramentarius*, it is not.	Fruiting body: with a cap to 4 inches wide, hemispherical, then convex, then expanded, soft, satiny white, with margin much incurved at first. Flesh: thick, firm, white, with good flavor and scent. Gills: free from stem, thin, crowded, white, then pink, then blackish brown. Stem: to 3 inches long, and to 2/3 inch thick, with ring usually persistent.	Fruiting body: umbrella-shaped, with cap that is to 2 inches broad, convex or plane, slightly sticky when moist, white or pale tan and with incurved margin. Gills: crowded, grown to stem or unequal and widest at center, at first dirty-white or gray, but becoming rusty when mature. Stem: to 3 inches long and to ¼ inch thick, spongy inside of hollow.	Beautiful fruiting body, with cap to 6 inches across, at first spherical, then convex, then almost plane, with surface slightly sticky, yellow or deep orange, and with margin minutely striated; surface covered with thick, angular, persistent scales. Stem: white or sulphur yellow, with ring and conspicuous cup.
Order Agaricales. Family Polyporaceae. *Strobilomyces* differs from *Boletus*, other common fleshy pore-bearing stool-shaped mushroom, in that tubes are white, are at first covered by veil, and do not separate easily from cap as they do in *Boletus*. Flesh of pine-cone fungus, at first a pale tan, when broken becomes a dark blue in few minutes, and exudes a reddish brown juice. Pores are to an inch long. Stem is less woolly than cap.	Order Agaricales. Family Agaricceae. *Coprinus* is black-spored, usually, but not always, with gills melting into black mass with age. This melting is sufficient character to distinguish most members of group, although relatively slender cylindrical shape of whole fruiting body is definitely characteristic. Plants all delicate and break easily. In some smaller species, caps split at top, but lower edge remains united.	Order Agaricales. Family Agaricaceae. Brown spored. Stem and cap easily separated; lacks cup but possesses ring. Species resemble white-spored *Lepiota* but while some lepiotas are poisonous, few if any psalliotas are. Among other better known species are the horse mushroom, the flat-top, the sylvan, the reddish brown, Rodman's and others.	Order Agaricales. Family Agaricaceae. Ochre-spored or rusty spored or yellow-brown spored. More than a dozen genera. Gills do not separate readily from cap; stem is essentially central, and usually with ring persistent on it when young, but without cup at base. Among better known species are the scaly pholiota, *P. squarrosa*, the sticky or fatty pholiota, *P. adiposa*, and this species. Common names suggest major differences.	Order Agaricales. Family Agaricaceae. White-spored. With central stem easily separating from cap, with both cup and ring, ring being white or yellow, ragged, large and soft, and cup being fragile and white or yellow. Widely distributed and very poisonous as are many other species in genus, although some are safe to eat. Unfortunately, resembles delicious Caesar's mushroom whose gills are white or yellowish, while here the gills are definitely yellow.
Spores are shed downward from pores when fruiting body is in its prime in fall and summer. While mature fruit body may become soft and decayed, old one may become dried and black, and resemble a piece of dead wood. Spores are dark brown in mass, nearly globular and roughened.	Spores are possibly carried by insects and other animals that light on the fruit bodies when they are inky and somewhat sticky. In that condition, it is not likely that spores would be wind-borne. A single plant may give rise to an enormous number of caps that appear in varying maturity.	Spores shed from caps, fall on suitable material and there develop a whitish network that persists from year to year if nourished properly. Commercial plantations are started by using this material cut into small pieces and placed with suitable food and water. Minor spore differences in cultivated and wild forms.	Fruiting early pholiotas may be found on lawns, meadows and along roadsides, from May to June, while scaly pholiota is found on living or dead trees from September through October and fatty pholiota on stumps or tree trunks from September through frost, the last being conspicuously yellow on dead or dying hardwoods.	Spores are shed from the fruiting body in June or November and develop in suitable food on ground, commonly along roadsides or in open woods but not so common in pine woods as is the Caesar's mushroom. It rarely appears in clumps or in great numbers in any restricted area.
Found on ground, not usually in great numbers but over most parts of U. S. and into Canada. Stem and cap are favored hosts for larvae of many insects and so specimens should be examined carefully before they are used as food. Rather rapid color change may be used as some index of relative freshness of plant.	Saprophytic, living on decaying wood, manure, leaves and other plant material. Most abundant in wet weather from early summer to late fall. Mass of fruit bodies is relatively short-lived. When collected for food or other purposes, caps are good for but a few hours, so not likely to be commercially important.	Naturally, found in pastures and grasslands or on cultivated areas where manure has been spread generously and where too much cultivation has not taken place. Yield in summer, small; but in fall, large. Commercially, plants are commonly grown in cellars, old mines and tunnels on manured beds properly watered.	Pholiotas live on dead or dying trees or on the ground and in general shape resemble the white-spored armillarias and purple-spored stropharias. The plant body must persist from year to year since fruiting bodies appear year after year on the same sites.	Poisoning by fly agaric is evident some 3 or 4 hours after fungus has been eaten, while related death angel may not be evident until even 40 hours later. In either case, poisoning may be fatal, preceded or not by a muscular paralysis. Death may follow 2 or 3 days after appearance of first symptoms or may be quicker.
Not easy to confuse this plant with any poisonous species. Not likely to be sufficiently abundant anywhere at any time to make up an important part of the volume of any collection. Related species are found in Europe, but this is most common in United States and Canada.	Among most delicious of mushrooms, whether considering shaggy manes or inky caps, not easily confused with any poisonous species, and so favored by amateurs. Parboil quickly in saltwater, then fry even more quickly in butter or, the caps may be eaten raw, salted or buttered. Spores used to identify inks.	This species probably is eaten as food more than all others, though it is not so important to commerce as the yeasts that cause ferments, or the rusts and smuts that destroy crops, or the molds that have their own role. Spawn develops best at 50° to 60° F. and mushrooms should develop in less than 10 weeks after beds are established.	Pholiotas here suggested are all edible and make fairly good table mushrooms; some prefer to peel off the sticky or sometimes tough caps before using them. A single great mass may weigh well over a pound and be adequate for a meal for an entire family.	Treatment of poisoning by these plants calls for a quick and thorough cleaning of the intestinal tract with salts, and mustard to encourage vomiting and bowel movements and, of course, a physician's help should be enlisted as quickly as possible. It is best never to eat fungi you do not know for certain.

COMMON NAME SCIENTIFIC NAME	HONEY OR SHOE-STRING MUSHROOM *Armillaria mellea*	JACK-O'-LANTERN *Clitocybe illudens*	VELVET-STEMMED COLLYBIA *Collybia velutipes*	OYSTER MUSHROOM *Pleurotus ostreatus*
DESCRIPTION	Fruiting bodies: to 12 inches tall, with cap to 8 inches across, and stems to nearly 1 inch in diameter. Usually honey colored, but sometimes white or dull reddish brown, being darker in center of cap, which is usually covered with dark brown to blackish scales, although these may be absent. Usually, many fruits in clusters.	Fruiting body: borne in clusters arising often from a common point, with stems to 5 inches long and ½ inch thick and cap, to 5 inches across, with raised portion in center when young, or depressed when old; margin often waxy. Whole plant a bright saffron yellow though flesh inside is soft and white or yellow.	Fruiting bodies appear in crowded masses on trunks of trees with stems bent upward, to 5 inches long, yellow when young, but densely covered with brown velvet when old and bearing caps that are to 3 inches across, at first red-brown, then tan, then glistening with sticky gelatinous substance. Gills: white, narrow, crowded.	Fruiting body often described as looking like an oyster, although this is not always obvious. Cap is developed unevenly to one side of short, thick stem or there is no stem, and gills are thin, extend down onto stem, are white, soft and spongy. Cap may be over 8 inches wide, with top, white or ivory and smooth.
CLASSIFICATION AND RANGE	Order Agaricales. Family Agaricaceae. White-spored. Differs from amanitas and lepiotas in that cap does not break cleanly and easily from stem, tissues of the two being continuous. Stem usually bears ring (annulus) though this is not always distinct. No cup (volva). Presence of annulus separates it from related *Tricholoma* and *Clitocybe,* in both of which stem and cap are grown together. World-wide distribution.	Order Agaricales. Family Agaricaceae. White-spored. Lacks both ring and cup; has stem and cap grown firmly together. Unlike as with otherwise similar *Tricholoma,* gills at their bases extend down onto stem. Many species: including edible, mealy-surfaced *C. laccata,* short-stemmed giant, ivory, funnel-shaped, lacquered, cloudy, fragrant, and clustered clitocybes.	Order Agaricales. Family Agaricaceae. Collybias differ from mycenas in that cap margin in *Collybia* is at first bent inward rather than straight, gills of neither are decurrent, and while cap and stem are grown together they are of obviously different texture. White-spored with relatively thin gills. Related *C. radicata* grows on ground, with flat cap and rootlike base to stem. Both common and well distributed.	Order Agaricales. Family Agaricaceae. *Pleurotus* differs from related *Hygrophorus* in that former has thin gills that are not much broadened near cap, while latter has gill waxy and broadened nearest cap. Among species of *Pleurotus* are oyster mushroom, the olive pleurotus, the elm pleurotus, the latter, of course, being most common on living or dead elms. All lack ring and but for off-center placing of stem, in some ways resemble *Clitocybe.*
REPRODUCTION	Spores shed in summer attack roots of host trees, entering bark and spreading under bark until roots are killed and spreading until eventually tree is killed. Growth may take place for many years before new fruiting bodies are produced, the hidden tissue often appearing as cords or strands.	Like the armillarias, some clitocybes may spread through cords from root to root underground. The spores, of course, are shed from the fruiting bodies and can attack wounded woody plants and there develop new plant bodies that may eventually bear other fruit bodies.	Spores from this plant may be shed from the fresh fruit bodies from earliest spring even into January, it being one of the fungi appearing most widely spaced through the year. Fruit appears either from dead trees or from wounds or dead spots in living trees.	Spores: white, elongate and when carried probably by wind to an exposed suitable wood, develop a plant body from which eventually new fruit bodies may develop. It is reported that fungus can be spread by placing infested wood on exposed suitable uninfected wood.
HABITAT	Host plants include many cone-bearers as well as forest trees and small fruits. In newly cleared lands, the diseased roots of forest trees may infect newly planted orchard trees or other cultivated woody plants. The dark subterranean cords may spread infection from tree to tree.	*C. illudens* is most conspicuous at base of decaying stumps and at night is often luminescent. Wood being rotted by this fungus may be collected and used to supply an eerie light in a tent while camping, though the luminescence is most conspicuous only in wet weather.	Plant may injure living trees by destroying the old wood that provides support. A favored species is basswood, but it is found frequently on other hardwoods. The fruiting is most vigorous in late fall and winter; records are probably of persistent fall specimens.	Oyster mushroom may be found on many kinds of wood, usually hardwoods. Fruiting bodies decay rapidly in wet weather and are almost always badly infested with insects, particularly active young beetles that crawl along gills. Slugs also feed on them rather frequently.
RELATION TO MAN	Economically injurious to important woody plants destroying timber and reducing fruit production. The fruit bodies are considered edible but not choice, as they are too tough. Often appears in large numbers after first killing frosts and may be canned for use as food.	A wood destroying fungus. Supposed to be poisonous or unwholesome, though bad element is apparently destroyed or removed by boiling. Soldiers in North Africa have written me of excitement caused at night by steady glow of roots cut in trenches in front lines.	Plant injurious to woody plants, but fruiting bodies provide excellent food for man. They may be collected and eaten fresh, fried in fat, or canned and used later in season. The related *C. radicata* is also edible, but not usually so abundant.	*Pleurotus* species generally edible, although some are better than others. Oyster mushroom may be tough when old. If specimens can be found young and free from insects, a single clump of fruit bodies may make a good meal for a whole family. Elm pleurotus common on city elms.

DELICIOUS MILKY-CAP MUSHROOM *Lactarius deliciosus*	PUNGENT RUSSULA *Russula emetica*	CHANTERELLE *Cantharellus cibarius*	FAIRY-RING MUSHROOM *Marasmius oreades*	PUFFBALLS *Lycoperdon* and *Calvatia*
Fruiting body: stool-like, when bruised, gives off a milky or colored juice. Cap: sticky when moist, to 4½ inches across, convex when young; funnel shaped when old; mottled orange to red or changing to green with similar juice. Flesh: soft, spongy, brittle, white to orange. Gills: decurrent. Stem: to 3 inches long.	Fruiting body: umbrella-like. Cap to 3 inches broad, sunken in center, sticky when moist, smooth, brittle, with skin peeling easily to show faint reddish flesh. Cap: red, but paler with age. Gills: not crowded. Stem: to 3 inches long, to ¾ inch thick, solid or pithy, fragile. Flesh: mostly white.	Fruiting body: like wavy margined cup only slightly depressed in center and with rather coarse, uncrowded gills extending down stem from beneath cap. Cap: to 3 inches across, fleshy, smooth, firm, like yellow of an egg. Stem: to 2 inches long, solid, flexible. Whole plant fragrantly scented.	Fruiting bodies appear usually in rings widening each year. Cap: to 3 inches wide, tan or ivory, smooth with rounded centers raised rather conspicuously, somewhat leathery in dry weather, reviving in wet. Stem and cap separate cleanly, easily. Stem: to 4 inches long, slender but tough. Flesh: firm and white.	White or whitish balls, when young, varying in size from one to a few inches through in *Lycoperdon*, to a maximum of 5 feet high and 4 feet wide in *Calvatia*, and in shape from spheres, to somewhat elongated vases, to depressed spheres with surfaces smooth or otherwise. Fruiting bodies, above ground.
Order Agaricales. Family Agaricaceae. White-spored, resembling russulas, but differing from them primarily in possession of colored or milky juice, which exudes freely in plant or more particularly, in broken gills. Gills: brittle, rigid, may or may not extend down stem in different species. Important species include scented milky-cap, the flesh-colored, the watery, the peppery, the indigo, the coral-colored, the fleecy, and others.	Order Agaricales. Family Agaricaceae. White-spored. Resembles *Lactarius* but lacks its milky or colored juice when broken and is, like it, ordinarily rather brittle. Few russulas "bleed" slightly and, if anything, cap of russulas are more brittle than those of *Lactarius* due in part to the bunching of tissues, a character not visible without a microscope. Many russulas are edible but a few are disagreeable and this one is reported to be poisonous by some.	Order Agaricales. Family Agaricaceae. Blunt-edged gills extend down onto stem distinguishing this genus from other white-spored fungi. Three common species include orange-yellow *C. aurantiacus* of doubtful food value, the vermilion-red, *C. cinnabarinus*, and this species, both of which are edible. Color usually sufficient identification for these, though gills of *C. cibarius* are fewer branched, and more decurrent than in *C. aurantiacus*.	Order Agaricales. Family Agaricaceae. White-spored. Closely related to *Collybia* and differing primarily on fact that while *Marasmius* may wither and dry with lack of moisture, it will revive when water is restored. *Collybia*, on other hand, will not revive once it has been wilted but is more likely to decay and be destroyed. This species widely distributed while related *M. cohaerens* is more limited to northeastern United States.	Order Lycoperdales. Family Lycoperdaceae. Related *Scleroderma* with underground fruit bodies thick-walled, and with black or purple interior, is in Order Sclerodermatales. Lycoperdales includes all true puffballs and earth-stars. *Calvatia*, the giant puffball, breaks the fruit body wall irregularly. Some, with papery walls, are classified under the genus *Bovista*. Related earthstar, *Geaster*, breaks fruit body to form a many pointed star that opens and closes in dry and wet weather.
Spores: shed from July to November, and landing on damp ground in coniferous woodlands, may germinate to develop a subterranean plant body that eventually will bear new fruiting bodies. Fruiting bodies: not commonly clustered in great numbers as is common with those mushrooms that may be found on stumps or on woody plants.	Fruiting bodies appear from July to October, from the plant body hidden in rotten logs or in the forest floor. This species is not common in the open, and some russulas favor pines and spruces, while some grow in sand and some are at their best in open hardwood forests.	In July and August, fruit bodies appear singly or scattered in groups on ground, usually in coniferous woodlands or in hardwood forests. *C. aurantiacus* grows in abundance from rotten wood, probably saprophytic. While this is classed as a white spored mushroom, spores are faintly yellow and elliptical.	Rings are formed as follows: A spore falls on suitable ground and develops a plant body that exhausts suitable food where growth begins. In season, fruiting bodies are sent up at edge of this roundish area. Next season, food is further exhausted, widening ring. This continues from season to season.	*Lycoperdon* species usually rupture more or less papery fruit body to free air-borne spores through definite area at top. Spores, wind-borne. Fruit bodies white throughout at first, but later black. A 5 lb., 3 oz. puffball yields about 7,000,000,000,000 spores. If each matured, second generation would be 800 times size of earth.
Food of the plant body is evidently associated with evergreen woods. While this species and some others are edible, there are a number of species that are not, and some that are poisonous. Stem in this species is frosted or covered with bloom at first, spotted with orange and turning green where touched.	Species name *emetica* assumes that this plant may serve as an emetic. Certainly, it has a strong and distinctive taste but there are large numbers of persons who eat it regularly and enjoy it, while some books label it as poisonous. Some go so far as to say that there are no poisonous russulas.	Orange-yellow C. is found from July to September; the yellow, from July through August; and the red C. from July through October. Yellow is particularly well known and favored in Europe as well as in the United States and Canada.	These fungi are common in grassy fields and orchards or on lawns, crops of new caps appearing from time to time from spring until fall and from year to year. Insects do not infest these mushrooms, commonly, and while drought may shrivel them, they may be made edible by merely soaking tops in water.	Plants are saprophytes living on decaying plant material either in open grassy fields or in wooded areas or in cultivated lands. One species, *L. gemmatum*, is often found in considerable numbers on well rotted logs, though pear-shaped *L. pyriforme* is even more partial to old wood.
Some consider this species a favored mushroom but others disagree. Since there are dangerous or inedible species in the genus, it is safer to avoid eating any of the milky-juiced mushrooms unless more exhaustive data than are here given are available to make identification sure.	Economic importance: small. Since fruits usually do not appear in great numbers. Not likely to appear in a mess of mushrooms unless mixed with others. It is possible that they have been considered dangerous because of their strong taste and because they may be mixed with dangerous plants.	Fragrance and nutty taste as well as abundance of chanterelle has made it famous and popular world over but more particularly in days of ancient Rome. To some, nutty flavor is somewhat bitter; and to some, orange-yellow species is considered as poisonous.	Favored table mushroom because of good qualities but more so because specimens may be collected, dried and then soaked for use as food instead of going through troublesome process of canning. Dried fairy-rings sliced and added to soups are delicious. Drying may be done in sun or in ovens.	All puffballs with white interiors and fruit bodies above ground are edible and some are delicious. Larger calvatias may make many meals for a family. Fruits may be sliced, parboiled in salt water and fried in butter or in hot fat to make a delicious dish. Should be eaten only when collected white.

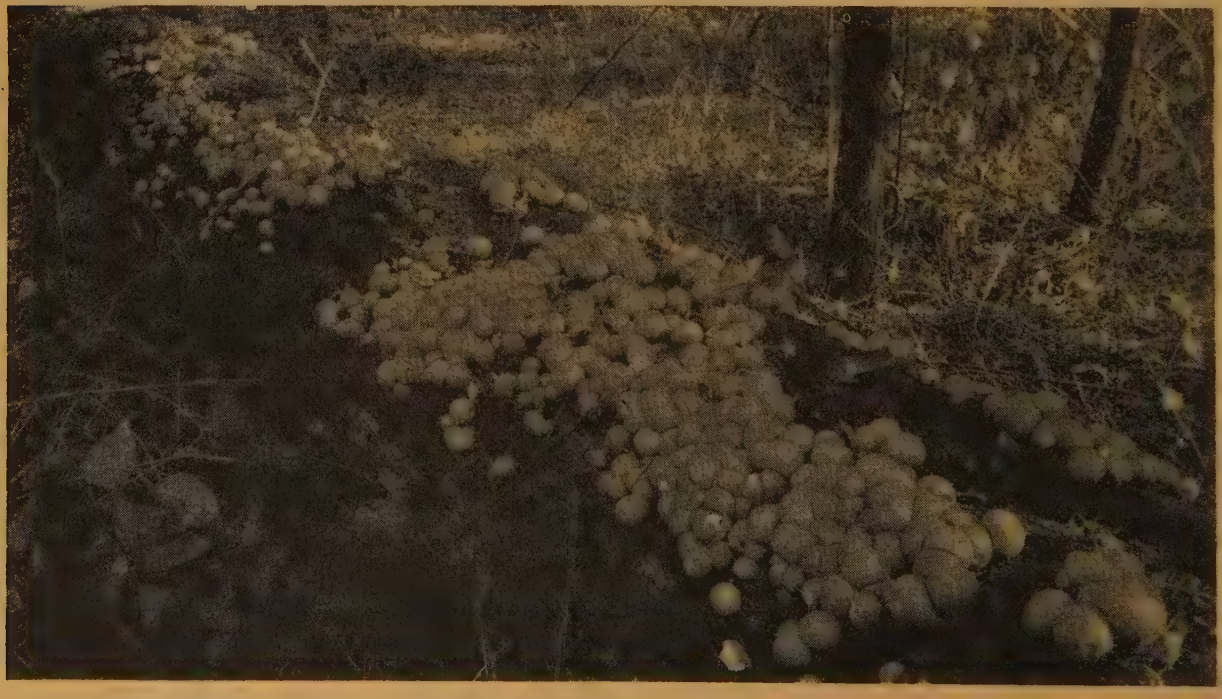
(Continued from page 307) We know that some are affected more than are others by poison ivy, by ragweed pollen and by other natural substances. Undoubtedly, we also vary in our reaction to poisoning by fungi. Cooking may make a great deal of difference in the quality of a mushroom. We know that some kinds are poisonous if eaten uncooked, or poorly cooked, but are perfectly safe if they have been once cooked thoroughly, and if the water in which they are first cooked is discarded. A thoroughly cooked mushroom to some is as unappetizing as a thoroughly cooked steak, so it is better not to rely on the cooking as a safeguard against trouble. Of course, this is not true of all mushrooms, since a well cooked fairy-ring mushroom may be as pleasing between the teeth as a partly cooked field mushroom.

We have used the term "fruit-body" rather freely in the chart data on mushrooms, and yet we have referred to something that is technically different from the fruits discussed in the insert "Our Fruit Stores." The mushrooms we eat are the spore-bearing portions of certain fungi that get their food wholly from other plant sources. The major portion of these plants is hidden in the material that they use for food. Usually, it is a white substance known as *mycelium,* or "spawn," capable of penetrating living or dead wood, or of extending itself from plant to plant underground. Some of the mushrooms preying on living plants are parasitic, while others, getting their sustenance from dead plant material, are saprophytes. The commercial mushroom is in the latter class, developing largely in the partly-decayed plant material to be found in manure. When the mycelium has developed to a certain point, the plants produce, rather suddenly, the spore-bearing objects that we notice readily. Really, then, a mushroom does not grow so rapidly as we might assume since it merely represents a rather sudden development of a plant part that may have taken a long time to develop. Conditions of temperature, light and, more particularly, of moisture, are among the important factors determining the appearance of the spore-bearing bodies. Of course, there is a tremendous wastage of the spores produced, and only an infinitesimally small number of those produced develop into mature new plants.

Since a generous proportion of the more important mushrooms live largely on dead plant material, they can be considered useful in clearing ground that may then be available for the growth of new plants. The fact that many of them destroy useful timber makes them most unpopular with lumbermen, and so we find infected wood and old stumps bearing mycelia frequently collected and burned in forest management practice.

There is a rich literature that anyone may use to train himself to know the common fungi better. In the writer's judgment, the best buy for a beginner is without question, *Toadstools and Mushrooms* by H. T. Güssow and W. S. Odell, published by the Dominion Experimental Farms, Ottawa, Canada, $1.00. Other good references include: *Mushrooms, Edible and Poisonous* by George F. Atkinson, Henry Holt and Company, (in libraries); *Mushroom Growing* by D. M. Duggar, Orange Judd Company, $2.00; *The Mushroom Book* by Nina Marshall, Doubleday, Page and Company, (in libraries); *Fieldbook of Common Gilled Mushrooms* by William Sturgis Thomas, G. P. Putnam's Sons, $3.50; *The Mushroom Handbook* by Louis C. C. Krieger, Macmillan, $3.50; *Mushrooms of Field and Wood* by Margaret McKenny, John Day Company, $2.00.

AN IMPOSING ARRAY OF A PUFFBALL, *LYCOPERDON PYRIFORME,* ON A ROTTING LOG. THERE ARE ENOUGH OF THESE FUNGI TO FURNISH MANY DELICIOUS MEALS. PHOTOGRAPH BY L. W. BROWNELL.



As We See It

Act Now on Pollution

Following studies, and on the basis of recommendations made by the Dern-Lonergan conference of 1934, the Lonergan Bill to control water pollution was introduced in the United States Senate in January, 1936. This was the first of a series of bills recognizing the interstate character of stream pollution, and, therefore, seeking effective federal control of this problem. A month after the Lonergan Bill was filed there appeared in the Senate legislative hopper the Barkley Bill, with its companion Vinson Bill in the House. These identical measures were also the first of a series—a series supported by the nation's leading polluters, and which sought to prevent control by providing for the old subterfuge of further investigation.

Lineal descendants of these proposals are now before the Congress. The Mundt Bill, H.R. 519, and its Senate counterpart, the Myers Bill, S. 535, are the legislative offspring of the Lonergan Bill. The Spence Bill, H.R. 592, is the illegitimate scion of the Barkley-Vinson proposal. Also pending are S. 330 and H.R. 587, introduced respectively by Senator White and Congresswoman Smith of Maine. These identical measures combine elements of both bills, but do provide for actual control and are, therefore, on the positive side.

Leading the fight for real water pollution control, ever since the days of the Lonergan Bill, has been the Izaak Walton League of America. It has been joined by most other conservation organizations, including the American Nature Association. We all have consistently supported legislation that meets the issue and seeks solution through establishing standards and enforcing them.

Arrayed against the effective measures, and active in support of "further investigation", have been the largest polluters. These included industries and municipalities content to dump their sewage in streams, irrespective of the interests of communities down stream. Health authorities, fearing loss of prerogatives, have largely been found on the side of those opposed to real control.

We have not been, we will confess, entirely happy that the drive for effective pollution control should be so largely in the hands of conservationists. This has created the impression, in our opinion, that water pollution control was being sought merely to assure more fishing and other aquatic resources. Protection and restoration of such vital resources would, of course, be an important by-product of clean waters. But the issue involves far more than that. It involves the public health, as we, among other Washingtonians, have grim reason to know personally after an outbreak of typhoid carried by oysters from polluted waters.

We, therefore, have no patience with those who, whether industry or municipality, blithely use our streams as a dumping ground. Nor have we any respect for office holders who obstruct sound solution of a serious menace because of petty jealousy. Such an attitude is a betrayal of the public trust. The public at large, civic groups, and all organizations truly representative of the public interest, should join in the pollution control drive. It is not the task of the conservationist alone, however great his appreciation of the importance of clean water may be; nor is he the greatest beneficiary.

The Mundt and Myers proposals represent a refinement of the pollution bills that have gone before—and gotten nowhere. They meet every reasonable objection. They provide that there shall be no new pollution after the act goes into effect, but they give polluters, both municipal and industrial, two years to eliminate their pollution. Further, the bills provide for a five-year extension if it can be shown that attempt has been made to comply with the act, but that, for legitimate reasons, it has been impossible.

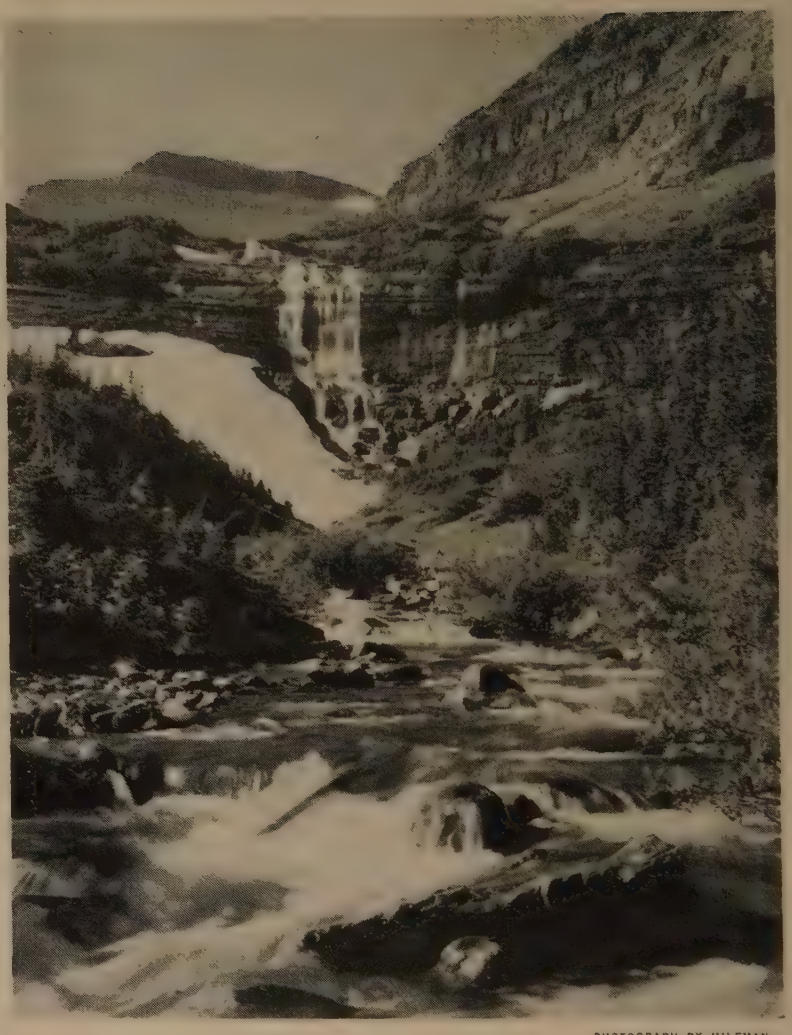
Furthermore, the measures make it a matter of policy to "encourage State and inter-State compact agencies to exercise their statutory authority in the prevention and abatement of pollution." The Federal authority would be invoked only after existing authorities had been given every opportunity to undertake control, and, six months after receipt of written notice, had failed to do so. Enactment of these bills would, indeed, strengthen the hands of State and inter-State agencies with any real desire to act, as well as goad into action those soldiering on the job. The measure provides, of course, that enforcement would be in abeyance if any provision "would be incompatible with expeditious progress of the war program."

We have delayed long enough with this pollution problem. Only in a few isolated cases, where conditions have become so vicious that action had to be taken, has there been any progress in control. Generally the situation is getting worse, despite the fact that the scientific and physical means exist to control practically all forms of existing pollution. It is up to the public, not as conservationists but as citizens, to demand effective pollution control. Let your Senators and Representative know how you feel about H.R. 519 and S. 535; that you want them to become law.

To some this article may seem most elementary; to others it will be a comprehensive summary of the importance of water. Whichever the case, it is often well to refresh our knowledge and renew our appreciation of Nature's gifts. And when we consider man's pollution of water, and the issue raised in the editorial on the page before this one, it is well to give some thought to—

The Natural History of Water

By FREDERIC W. NORDSIEK



PHOTOGRAPH BY HILEMAN

High in the mountains Nature stores a supply of water, releasing it through stream and over waterfall that it may give its life and strength to the land.

THE ancients were philosophically sound, if scientifically incorrect, when they thought that water, together with air, fire, and earth, made up everything, whether living or inanimate. Water is omnipresent; it is a precious, inexhaustible natural resource, although when abused by man it works against him through erosion and in polluted waterways.

Water covers a larger proportion of the world's visible surface area than does land, but below the grandeur of lake and river lie other equally vast stores of water, hidden underneath the ground. The water that pours out of artesian wells comes from immense underground lakes, lying in porous layers of the earth. Springs are resurgences of buried brooks. Many lakes and ponds lack visible inlets or outlets, but are filled or drained by subterranean streams. Caves and abysses of today were carved by present or former underground water courses. But even the bulwark of earth does not necessarily protect hidden waters from abuse by man, for wastes improperly disposed of can contaminate them, so that water from artesian wells sometimes requires purification before it can be drunk.

Water is ever present in the air, usually as invisible vapor. This atmospheric moisture, which comes from surface evaporation of water bodies, from the moist ground, the breath of animals, and plant leaf surfaces, has two possible fates. It may recondense as dew, or hoarfrost in the wintertime, and ride upward on rising columns of warm air. As this water-laden air rises it expands, because atmospheric pressure upon it diminishes. This expansion cools it. Since air can carry less and less moisture at successively lower temperatures, a point is soon reached where the water vapor condenses to form clouds. Clouds may be kept suspended by air currents, but, if this support fails, the water content of the clouds falls back upon earth as rain or snow.

Rainfall is normally a beneficent thing, for it returns to earth the water needed by plants and animals, most urgently needed as we shall see presently. Where the earth has its normal cover of vegetation, it takes back to its bosom the water of the rain, holding this moisture in roots and soil where plants may use it, and releasing the water slowly to streams and ponds, where it is available to animals. But wherever wasteful lumbering and shortsighted land-clearing practices have stripped the soil of plant cover, falling rain sluices unimpeded across the earth, eroding away the fertile topsoil, the accumulation of centuries. This irreplaceable soil is carried down the rivers, eventually clogging waterways near the sea, so that they must be dredged continually to keep them open

PHOTOGRAPH BY W. F. HALLOWELL

Taking moisture from the earth in various ways, Nature stores it in clouds from which it may return to the earth as rain or snow, and perform its vital functions to life.

for navigation. Thus soil that could have supported valuable timber, or other growth, becomes, instead, an impediment to commercial activity. Furthermore, this rapid drainage of eroded areas means that shortly after a rainfall most of the water has gone down to the sea, so that brooks soon run dry, and animals cannot find water to drink.

Erosion scars on the earth's face result from man's shortsightedness, but water in the form of ice also serves proper, natural functions in the shaping of the world. Far back in geological time, when much of the area now the United States was covered by a great continental glacier, this ponderous, slow-moving river of ice, by its great weight and the abrasive action of rocks trapped beneath it, carved out the surface of the country as we know it today, grinding down mountains, gouging out valleys, building up gravel hills called moraines. In a limited way glacial action still continues today, for glaciers form wherever more snow falls each winter than melts each summer, pressure of the accumulated snow burden quickly converting snow to ice. Modern glaciers are found in northern latitudes, and at high altitudes.

A related activity of water in changing the appearance of the earth is frost action in regions of cold climate, again particularly at high altitudes. On the exposed rocky knobs of mountain tops above timber line, moisture seeps into cracks of the rock during warmer days, and then, when temperatures drop, this water freezes and expands, prying off pieces of rock with great force. Another frost action of importance on mountains is the churning of the sparse soil found in those places. This phenomenon of frost churning may be observed in miniature wherever winters are at all severe. As the moisture in the soil freezes, large ice crystals form that rend the soil, and force it upward in sizable mounds. At high altitudes such churning is so pronounced as to redistribute the soil constantly during freezing seasons.

A third, and final, proper function of water in shaping the earth is the action of ocean waves and currents. Shifting sand dunes all along the ocean beaches are as clay under the sculpturing influences of waves. Waves, aided by currents, constantly alter shores and channels, turning peninsulas into islands, changing landlocked ponds into bays, and then often converting each back in time to its original form.

So it is clear that water plays a fundamental role in shaping the external world. What is water's importance to animals and plants inhabiting that world? Aside from their need for oxygen, the most pressing requirement of living organisms is a demand for water. This is not surprising when we recognize that water constitutes from sixty to ninety-nine percent of protoplasm, the living juice of plants and animals. Water's great contribution to life stems from the fact that it is the universal solvent. This means that water is able to dissolve and carry in solution a greater variety of gases, liquids and solids than can any other fluid. Animals and plants, dwelling in oceans, lakes, and streams, depend upon oxygen dissolved in the waters that surround them. The tragedy of river pollution lies in its interference with this oxygen-bearing function of water. Industrial and domestic wastes discharged into streams are largely organic material, which soon decomposes, using up oxygen, and taking this oxygen from surrounding water. All of the dissolved oxygen may quickly be usurped, with the re-

U. S. FOREST SERVICE PHOTOGRAPH

The scars of erosion are the evidence of man's failure to conserve water and aid it in doing the task for which it is assigned. Pouring off the over-grazed and treeless hillside, the water carries the topsoil, built up through centuries, into streams and away.

sult that animals and plants in the water die of strangulation, and a once lovely stream becomes an unsightly, malodorous ditch. This abuse may readily be prevented by the treatment of wastes, so that their oxygen demands are satisfied before they are discharged into streams.

Land-dwelling plants and animals, of course, take their oxygen directly from the air. But within the tissues of all living things, except the higher vertebrates whose blood pigment is a special device for this purpose, water repeats its oxygen-bearing function, carrying oxygen to each individual cell, where it is needed for oxidation or burning of food substances to yield the energy fundamental to life itself. By the same token, water of the living fluids bears to each cell food substances from the organs of absorption or digestion, and then carries away to organs of excretion the waste materials resulting from cellular oxidation. In the animal body circulating fluids also carry in solution the hormones, so-called "chemical messengers," which are secreted by ductless glands to perform vital regulatory functions, and which often do their work at sites far removed from the gland where they were elaborated.

Water in the circulating fluids not only transports materials for the complex chemical reactions fundamental to plant and animal life, but also makes possible these very reactions. An axiom of chemistry is that reactions usually take place only when the interacting substances are in solution. This rule may be demonstrated with common baking powder, which is stable indefinitely while dry, but which reacts to give off gas as soon as it is moistened. Such proof may be extended to a living thing by considering the seed, which remains quiescent as long as it is dry, but sprouts when enough moisture is supplied.

Although this discussion must confine itself to highlights of the functions of water in living things, two more such aspects merit mention. One of these is the fact that foods may be (Continued on page 332)

Without ponds, lakes, and streams, aquatic and other forms of life dependent upon a watery habitat cannot live. Yet man drains, pollutes and otherwise destroys much of this resource.

PHOTOGRAPH BY J. W. WHEELER

Virginia Was Once England's Wild West

By GORDON W. JONES

★

The bison, as pictured in Catesby's *Natural History of Carolina.* Catesby called the tree "Pseudo Acacia hispida floribus roseis", and said that he had seen bison browsing on the branches, and had found bison dung beneath the tree in exploring in Carolina. The tree is now known as *Robinia pseudacacia.* Photograph courtesy of the Richland County Library of Columbia, South Carolina.

"AN OPASSOM," wrote John Smith, obviously with a chuckle, "hath a head like a Swine, and a taile like a Rat and the bignes of a Cat. Under her belly shee hath a bagge wherein shee lodgeth, carrieth, and sucketh her young."

This queer New World hodgepodge was the strangest American beast, in the Elizabethan Englishman's eyes. The other mammals and birds and plants were not radically different from those he had seen in Europe; not different in kind, that is, but vastly different in quantity. The profusion of things natural awed the Virginia adventurers of 1607.

They found a land that was covered with one vast green carpet a hundred feet thick, merely wrinkled by the mountains, and cracked only by the fresh bright rivers and the lush savannas along their banks.

Within this carpet there flourished probably one of the most luxuriant non-tropical biotas the world has ever known. The tops of great trees formed a dense umbrella over mile after mile of parklike woodland where countless wild animals, not wary then, lived a stable existence. The droves of deer and other game animals lived in perfect balance with abundant predatory animals. The numbers of prey and raptors varied little from year to year.

The red men of this wilderness were too few, too poorly equipped with weapons, to tip this splendid balance of Nature. They hunted by fire, snare, and arrow, but what were these against such an assemblage of the wild? No, a race inconceivably more rapacious than they was destined to change, in a few years, what Nature in God had planned and built for thousands of centuries.

The vanguard of this destructive horde were enraptured by what they saw and smelled. After a long, dirty sea voyage, a breeze from the Virginia forest carried them the lovely perfume of billions upon billions of flowers and pines.

Wherever they landed they waded knee-deep through beautiful flowering plants, which thrived in the gloom cast by immense trees towering above. Those giants stood at a respectful distance from each other. In fact, the early settlers found that whole infantry companies could form in martial line-up in the woods as well as in the clearings, and that mounted horsemen could dash freely through the forest.

All the early explorers and writers, from Hariot to Byrd, were awed by these trees. There were oaks of several varieties, reaching upwards several modern office-building stories before the great boughs began. Many were even greater than this. George Percy reported that vines "as thick as a man's thigh" ran to the tops of these trees in great abundance. These were the grape vines by means of which Boone saved his life from pursuing Indians when he swung across

The skunk as pictured in Catesby's *Natural History of Carolina*. There appear frequent early accounts of meals of delicious skunk meat. Also early writers regaled their European readers with accounts of this animal spraying dogs and incautious human beings, although none of them seems to have admitted to being personally sprayed.

Kentucky valleys by a route that left no trail.

Tremendous pines, as rot-resistant as the oak and cedar we now know, grew in profusion in sandy soil and in mixed habitat with the trees the grape vines preferred: oaks, maples, walnuts, and tulips. This last abundant tree was often ten feet in diameter. Lawson mentioned a prominent citizen of his day, who, as a young man, had lived in a hollow tulip tree. There had been room for his bed and furniture in that same cavity!

It is not generally realized that the great beast of our plains once roamed these forests east of the Appalachians. Apparently the bison, or buffalo, never became abundant here. Nevertheless, all the early explorers saw a fair number of them. Samuel Argoll wrote enthusiastically in 1613 of "shaggy coated cattle in great herds." The other writers, however, mentioned only individuals, not herds.

Byrd described the beast as being of enormous and terrible size, with long curly hair. The only suggestion in the old books that bison may have been common is his remark that the settlers made mattresses of that hair. He hinted that, in 1730, the animals were mostly found toward the mountains, beyond the plantations. What would he have said had he known of the millions on the Great Plains still farther west!

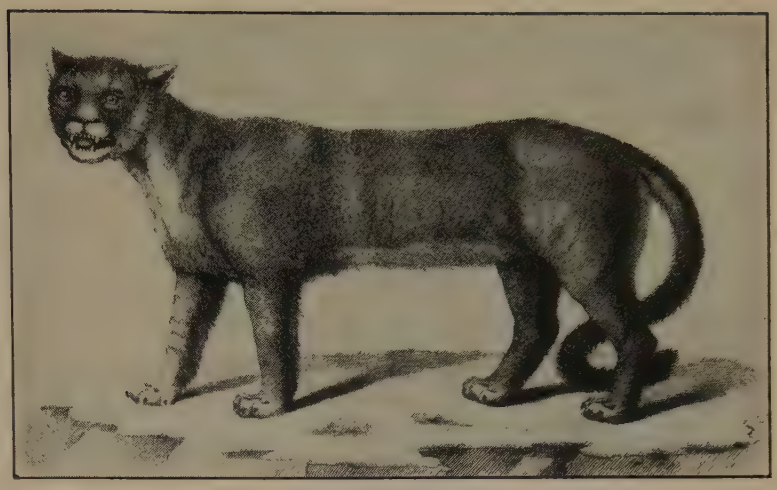
In his "Dividing Line History," an account of his surveying expedition in 1728 along the North Carolina border, Byrd makes frequent note of "buffalo tokens." Only one animal, however, was seen, and killed, by his party. This was a two-year-old bull, larger than an ordinary ox, with a great hump that Byrd thought contributed to his enormous strength.

Byrd noted further that some people had durable stockings that had been knit of the long but silky hair on the neck below this hump. The Indians made spoons of the short, strong horns, which "will fall apart whenever poison is put in them."

We know he did not exaggerate when he claimed the full-grown animal's body was six feet high, and would weigh 2500 pounds. In a later expedition to the same region he killed another young bull, and let his dogs tease a fierce, solitary old one, an outcast, no doubt. This fellow contemptuously held his ground and furiously ran at the dogs, cocking his "ridiculous little tail" and grunting like a hog. But the dogs were too nimble for him.

Apparently the elk, "as big as horses," according to Byrd, were more abundant than the buffalo in colonial Virginia. My own home plantation, established a few miles west of Fredericksburg during the Revolution, was named Elkwood, originally, because of the numbers of elk the first planter saw there. The early settlers were impressed by the enormous antlers and thrilling bugling of the male elk in the gorgeous primeval autumn. Lawson brusquely called the elk a "monster of the venison sort."

Far more abundant were the familiar little white-tailed deer, which resembled the English kind. They were the mainstay of every explorer and hunter, every small settler on the fringes of the colony. And they seemed to increase with the increasing thickness of the undergrowth that followed the white man's activities, before the rifles became too powerful and too numerous. Their hides furnished clothing, their flesh important food. Byrd's 1728 expedition saw them frequently and killed nearly thirty for meat. Considering how wary the present-day deer are, it is remarkable how often the early men write of seeing deer foraging quietly at every turn. The evidence of the tameness and profusion of beasts in the untouched wilderness is striking in every old natural history.



The cougar as pictured in Godman's *American Natural History*. According to Byrd this cat ruled as absolute monarch of the forests, serving as a predator to keep other wildlife in balance. Courtesy of Gittman's Bookshop, Columbia, S. C.

From all accounts, bears seemed to be nearly as abundant a game species as deer. Byrd's party ate thirty-one during their surveying trip. Lawson wrote that during one winter in the late 17th century more than five hundred bears were killed in two Virginia counties alone. Seton's "clown of the woods" had become too frisky with the settlers' crops and stock. Now bears are to be found only in the grim depths of Dismal Swamp and in the Alleghanies, wary, hard to see.

But they were by no means wary two hundred years ago. They were harmless unless molested, often just too independent to move far. Byrd notes the piles of gravel that he supposed were made by the bears in the shallows of the James River at the site of the present Richmond. The famished beasts by the hundreds, thin from their winter's sleep, rushed to the shallow river and sat on these gravel heaps in eager hunt for the fish, which shared in the early abundance of everything.

The fish stayed the bears' hunger until the berries, of which the English adventurers wrote so delightedly, ripened. From then on, an increasing quantity of food was theirs until the great mast harvest of the fall, when the gigantic oaks began to shower carloads of acorns, and the tremendous grape and persimmon harvest grew sweet.

Under many oak trees explorers were puzzled by brush heaps composed of small limbs of the trees above. The shrewd bears, avid for acorns, gathered their nuts as far out on the limbs as was safe. Then they bit off the rest of the boughs, and hurried to the ground to feast in comfort.

The bear was surely the favorite wild animal in Byrd's eyes. The meat, product of that rich harvest of Virginia's loam, was of high quality. It was thought to "be less apt to corrupt than any other." The abundant fat was the "sweetest" of all. Byrd bluntly said it did not rise in the stomach. The same bear's grease was almost a cure-all ointment in the eyes of the frontiersmen, served the purpose of lard, and was used in candles and soap and hair oil. Nothing could be warmer than a bearskin robe.

Even their excrement found a use among the resourceful pioneers. "Bears are black and so is their dung," wrote the elegant William Byrd, "but it will make linen white, being tolerably good soap, without any preparation but drying."

Nearly as common as bears were the little, dog-like wolves. Every writer, perhaps eager to soothe the fears of prospective colonists, was contemptuous of their size and courage. Nothing like the European wolf, he ran from man. But he certainly did not run from man's livestock. Durand de Dauphine called him the only thief the planter had to fear. He said that for every wolf's skin the state rewarded the killer a barrel of tobacco.

Beverley, the historian, delighted in the rude sport of dashing through the forests after wolves in the best fox-hunt manner. That is a commentary on the open nature of a woodland that was so dense by the

The black fox squirrel as it appears in Catesby's *Natural History of Carolina*. There were several large and small squirrels in early Virginia. The flying squirrel delighted many, and King James requested a specimen for his royal park.

time of the Civil War that it was the despair of the Union armies.

Wolves skulked behind every hunting and exploring party, hoping to find some discarded meat. One hunter merely wounded a deer, which limped away. Led to the spot where it had finally fallen, by the croaking of ravens, he was surprised to see a wolf slip away. It had already begun to feast on the deer. Wolves long remained abundant and took a heavy toll of the early farmers' stock. As a result, wolf driving became a popular (and seemingly necessary) sport. Nearly a century after the first settlement the court of one of the older counties set a date for a thorough scouring of the woods.

Shortly after 1734, Orange County, which lies only a hundred miles from Chesapeake Bay, offered a bounty for wolf's scalps. In the next two years this cost the county half of the tax receipts. Wolves were still found there in 1800.

Semper Idem

By RALPH J. DONAHUE

Over the dawn, dark wings are moving,
Wings of new jade against a pearl bow.
Swiftly and high, they taunt by their measure,
We of the Earth-bound, dwelling below.

Then, at the noontide, pacing the thunder;
Leagued with the cloud-rafts that shadow the plain,
They tilt down the wind's track, and dive on the timber
To startle the woodfolk in blatant refrain.

Now at the evening, their wings tinted amber,
Crows seek their roosts as the day looses breath—
Nature and Life will halt for the season
That knows the last crow's heart silent in death!

Yes, wolves were found everywhere. Lawson was awakened one night, when encamped near a Carolina swamp, by the "dismalest and most hideous noise that ever pierced my ears," the noise of wolves on the prowl, and screaming panthers stalking about the night with lordly disdain.

The explorers knew of wolves in Europe, but America had a lion! According to Byrd the panther ruled absolute monarch of the forests. Big, powerful, unbelievably abundant in the early days, it is fortunate that he did not develop man-killing propensities. Apparently man was the only living being he feared. Deer, elk, buffalo, were all his prey. Such was his function, to keep down to the limits of the vegetation the numbers of grazing animals. He was an essential element in the grand balance of Nature. He prevented such debacles as we have seen in the Kaibab Forest, where all predators were destroyed, and the deer finally increased so fast as to kill off the vegetation and die of famine.

Even the bear, which many a frontiersman knew could put up a great fight, was no match for the fierce puma. However, the lion preferred to catch the drowsy animals napping. Byrd's party found a fat bear killed and partially eaten by a puma. At the approach of the men the puma sullenly retired. How prophetic! In the face of the white man's ruthless march most of our wild animals have retired.

Both Byrd and Lawson wrote mysteriously of a tiger they never saw but which was reported in the mountains of the colonies.

Lesser wild cats were abundant, sometimes being shot in broad daylight! Nothing was wasted in those early days, and we are told that the meat of this animal was as white as veal and fully as sweet and delicious.

These fierce little beasts were said to crouch on limbs and pounce on the necks of unsuspecting deer, severing the spinal cord with their powerful jaws. The fecund deer had many enemies, indeed.

If a lunch of wildcat seems strange, the frequent notes of a meal on delicious skunk meat make one wonder about our ancestors. They were rough, vigorous men, and consequently anything suited their rapacious appetites. But all the writers at the same time regaled their European readers with side-splitting accounts of this queer black and white animal, which urinated on offensive dogs and incautious human beings. But never did an author admit having been caught!

Lesser beasts were innumerable. Squirrels, large and small, teemed. The lovely little flying squirrel delighted all, and King James eagerly requested specimens for his royal park.

Everyone marveled at the abundance and industry of the beaver. The fur was as much prized then as now; the flat tail was a delicious morsel. The little beaver meadows resulting from drainage of their ponds were rich breaks in the forest, where sun-loving plants grew in profusion. Robert Evelyn said that the woods were so full of little swamps and ponds in those days that "it is no wonder ague is so common." Beaver work!

Byrd, the philosophical, was very respectful of the king beaver who was the foreman of each colony, and who, he thought, roused the whole gang whenever the dam was tampered with, directed all engineering, and settled all disputes.

The fish of the beaver ponds were fine prey for the abundant otter, which haunted every watercourse. Foxes like the English ones gave promise of future fashionable hunts.

The first explorers even reported a monkey. But this turned out to be merely the droll raccoon, which is still as common as ever, apparently, in many sections, although much harder to find.

Just as impressive as the (Continued on page 332)

The "Cortez Tree" on the banks of the Rio Guarabo in Cuba is a ceiba that is a gnarled reminder of the exploits of Spain's empire builder.

Ceiba caribaea is the "God-tree" of the West Indian natives. Its Javanese relative, *C. pentrada*, supplied most of America's kapok before the war.

Ceiba, King of Tropic Treedom

By GIL STUCKER

THE sultry West Indian tropics doze in perpetual siesta beneath canopies of palms. To the casual *turista* they would at first seem to be the only trees. Everywhere—from the stately aristocrats that line the *avenidas* to their pot-bellied brethren of the jungle, or the twisted hooligans of the wind-torn coasts—they have overrun the islands. Splashed against the ruddy dawn, the pale blue of mid-day, the fiery skies of sunset, their feathered topknots forever sway to the rhythm of the winds.

But, sooner or later, rising from their midst—"among them but not of them"—appears the solitary figure of a ceiba (sáy-bah), the kapok tree.

Ceiba caribaea is native to the West Indies, yet stands aloof like some strange and haughty monarch. It seems oddly foreign to the floral hodge-podge about it, an incongruous giant that has outgrown its world, disdaining the low-life of the jungles and the company of ragamuffin palms for the limitless sky.

Strewn among the root swellings at its broad, buttressed base lie fallen seed-pods, cracked and bursting with the satiny white fluff of their insides. This is kapok, the "silk-cotton" that has found so many industrial and commercial uses in the North. A hundred feet or more above, carried aloft by the straight smooth shaft of a trunk eight feet in diameter, great limbs branch out into an open crown of foliage 150 feet in breadth.

Time has relieved the old ceiba of the prickly excrescences of youth, horny spurs that armored the growing tree. The bald bark is buffed to high luster by the winds and rains of many years. How many years a ceiba may endure is a matter of dispute—students say three hundred; others put it at a thousand.

To the simple colored folk who live with this tree, it is ageless. As if the tree were rooted in eternity itself, it seems as though there never was a time when it was not there to offer cooling respite from the tyrant sun.

The palms have been prodigal in their material

gifts, providing the people with framework, walls and roofs for their homes; food and drink from the *coco;* fibers from the *corojo* for tough rope; finer strands of the *jipijapa* for weaving "Panama" sombreros.

But when the soul hungers, the natives go to the ceiba. It is the "God Tree." When they seek forgetfulness of their sordid lot and feel the need for something beyond themselves—greater, bigger and more lasting—who can say but what they find some spiritual solace under the boughs of this living deity. There is a god-like and enduring element in that passive majesty; that silent strength that survives through the centuries in spite of the calamities of fire, flood and hurricane this land is heir to.

In Jamaica a touch of voodoo gives the tree an added mystery. Silk-cottons bordering cemeteries are veritable hotels for disembodied spirits. It is customary, it seems, for the ghost of the departed to forsake his grave several days after burial and take up residence in the nearest ceiba. There, under the direction of the local witch-doctor, he assumes certain sinister duties as a wraith. Thereafter, with an energy never displayed while alive, the spook sallies forth nightly from his tree, preying upon the susceptibilities of former neighbors; haunting, bewitching, and making life generally miserable for the community.

COURTESY NETHERLANDS INFORMATION BUREAU

Javanese natives gather the pods of ceiba, the kapok tree. Harvest time occurs during September, October and November. A ten-year-old tree will yield six pounds of floss; an acre of ceibas may produce six hundred pounds a season.

In most of the West Indies, however, ceibas are benevolent beings, particularly useful in protecting habitations from evil spirits and wild animals. This, plus their exalted nature, is responsible for the disconcerting wanderings of many back-country roads and trails. Rather than fell these guardians, the natives build their thoroughfares around them, a fact that may have given the tree its earlier name of *Eriodendron anfractuosum,* translatable as "the road-bending-wool-tree." Similarly, where large areas of jungle have been cleared, the trees have been left alone in their glory on open prairies and cultivated fields.

How much of this superstition is African in origin is debatable. That the ceiba was considered sacred over much of Central America long before the arrival of black slaves to the New World, is known. Padre Francisco Nuñez de la Vega, Bishop of Chiapas, writes of the tree being worshipped by the aborigines, who, believing their ancestral stock born of the roots, honored it with elaborate rituals during tribal councils.

Much of Latin American history is symbolized in these trees. They might be called the "Charter Oaks" of Cuba. Over the banks of the Rio Guarabo near Trinidad town leans the gnarled "Cortez Tree," reminiscent of the Great Conquistadore and his final sailing for the Conquest of Mexico. The "Peace Tree" of Santiago, under which Spain's tyranny came to an inglorious end, still stands as a living monument to Cuba's independence. At Ceiba del Agua another silk-cotton marks the Instituto Civico Militar, the Island Republic's national home for fatherless children.

Having relegated tree-worship to the realm of mythology, our American approach to the ceiba has been on a strictly commercial basis. As "corkwood," the timber never found favor on the market, but its product, kapok, has become universally desired.

It is with the Java species, *Ceiba pentranda,* that we are principally concerned. Although the tree is of fairly wide distribution throughout the tropic regions, growing wild in Africa as *Ceiba thonningii* and *C. guinensis,* in America as *C. caribaea* or *C. casearia,* and in India and Ceylon as *C. pentranda,* it is only in Java, where conditions are most favorable, that the cultivation of kapok has proved successful.

On this island, which became the world's chief source of supply for this material, the Indian species of tree was introduced, along with teak, by the Hindus during their migrations between the third and sixth centuries. These inherently religious people developed the ceiba-complex at an early date, planting the trees around their temples in Bengal in the Middle Ages. That they carried this association with them to the East Indies is evident from the relief

carvings of ceibas on the ancient Hindu ruins of Boroboedoer and Djolotoendo in central and eastern Java. These date back to 859 A.D. and 976 A.D., respectively.

Kapok was first brought to the attention of Europeans by Dutch traders in the 17th Century. They reported the Javanese natives using it to stuff cushions and pillows. It was not until 1893, however, when the product made its official debut as an article of commerce at the World's Columbian Exposition in Chicago, that manufacturers took serious notice of it.

Between that time and the Jap invasion of the East Indies, "tree-silk" grew steadily in demand. It became a favorite for upholstery stuffing. Because its low thermal conductivity made for ideal mattress filling, it was closely identified with "the stuff that dreams are made of." Pillows grew softer. The magic of kapok had entered our homes. It even followed us on camping trips, where its properties of insulation and resiliency were put to use in our sleeping bags. Kapok became synonymous with comfort.

Eventually, along with most other things, our prize padding went to war, assuming a new and greater rôle in equipment for the armed forces. It was woven into cloth for the Army, proving as warm and twice as light as wool; made blankets and trench coats; insulated tanks and airplanes; lined flying suits for the Air Corps; filled the floats of Army assault-bridges; replaced cork in Navy life-jackets and other appliances where lightness, moisture-resistance, and floating power were needed. There seemed no end to the possibilities of this wonder-material.

Then—Java fell to the Japs. The source for ninety per cent of America's requirements was cut off. We had built up a reserve, but that would not last. The cry went up for new sources, and we turned, first, to the kapok growing wild in our own tropics. Surveys, however, discovered many discouraging features in the American variety. The pods of *Ceiba caribaea* tend to burst prematurely, exposing the precious floss to damage by dust, wind and rain. If the unripened pods were forced upon unnaturally, the fibers were found to lack sufficient resiliency and buoyancy. This failing, plus the immediate demand, scarcity of manpower needed to harvest the floss, absence of facilities to transport the baled product to shipping points, and the inaccessibility of many of the trees combined to eliminate Latin America as a commercially-producing region. In a few choice localites, some efforts were made to establsh small kapok plantations, but these were experimental in nature.

The problem seemed insurmountable. Then, as so often happens, we found the answer in our own back yards—uncounted acres of it. The lord of the jungle, the prince of stuffings, was succeeded by those lowly plebians of the northern prairies, the milkweed and the cattail. Grim necessity, in this instance, gave birth to a new and curious industry, the harvesting and processing of weeds.

COURTESY NETHERLANDS INFORMATION BUREAU

Kapok floss, the black spots in it being seeds. At the top are open husks of the pod and, at the bottom, the core of a pod. The seeds are used to produce a cotton-seed-like oil that is valuable.

Wonders were discovered in common roadside pests. Milkweed was found to compare well with kapok; the fibers of both were hollow and remarkably alike in size, buoyancy, elasticity and moisture-resistance. A mere three pounds of fluff from the pods would float a shipwrecked seaman for days, perhaps until rescue was at hand. In little time it was being used as filler for life-saving apparatus and as padding in "Mae West" life-vests and flying suits. *Typha latifolia*, the cattail, proved a close rival, its fluff becoming known on the market as "typha."

Processing plants sprang up in the north-central states and began the job of producing domestic kapok. The Burgess Battery Corporation of Chicago erected a "typha gin" at Ashippun, Wisconsin, and paid $2 a thousand for cattails C.O.D. Farmers found the weed "easy pickings," realizing $30 an acre in some cases. Unlike milkweed, which must be picked during early September, when farm labor is at a premium, "typha" can be harvested throughout autumn and until late March the following spring.

It is estimated that we have 1,000,000 tons of milkweed growing annually over seven western states. During 1944 "weed battalions" composed of Boy Scout Troops, students, 4-H Clubs and farmers combed this area. A harvest, (Continued on page 332)

Bayberries Still Serve

By MAUD MACDONALD HUTCHESON

BAYBERRY candles have kept the favor they enjoyed with our great-grandmothers. They still burn slower and better than most ordinary candles, are not greasy to the touch, and in warm weather do not melt and fall dejectedly over the candlestick. Their delicate woodsy fragrance when burning still fills the long winter nights with memories of high summer and promises of spring.

The bayberry bush was also known as the candleberry bush, the wax myrtle or the tallow tree. Bayberry bushes are lovers of the seacoast and grow in profusion on Cape Cod, where they continue to be the source of a thriving candle-making industry. Much of the harvesting is by hand, as in the mid 1700s, when the Swedish naturalist Kalm visited America. To him the small, grayish-colored berries looked "as if flour had been strewed on them." They are gathered, he noted, late in autumn, when ripe, and thrown into a kettle of boiling water. As the fat melts it rises to the top and may be skimmed off. The substance is allowed to congeal, and, while at first its color is nondescript, with remeltings it becomes a woodland green. Its fragrance when burning is elusive and distinctive.

Bayberries are said to be harbingers of good fortune. Burning the candles at Christmas was usual along our coast.

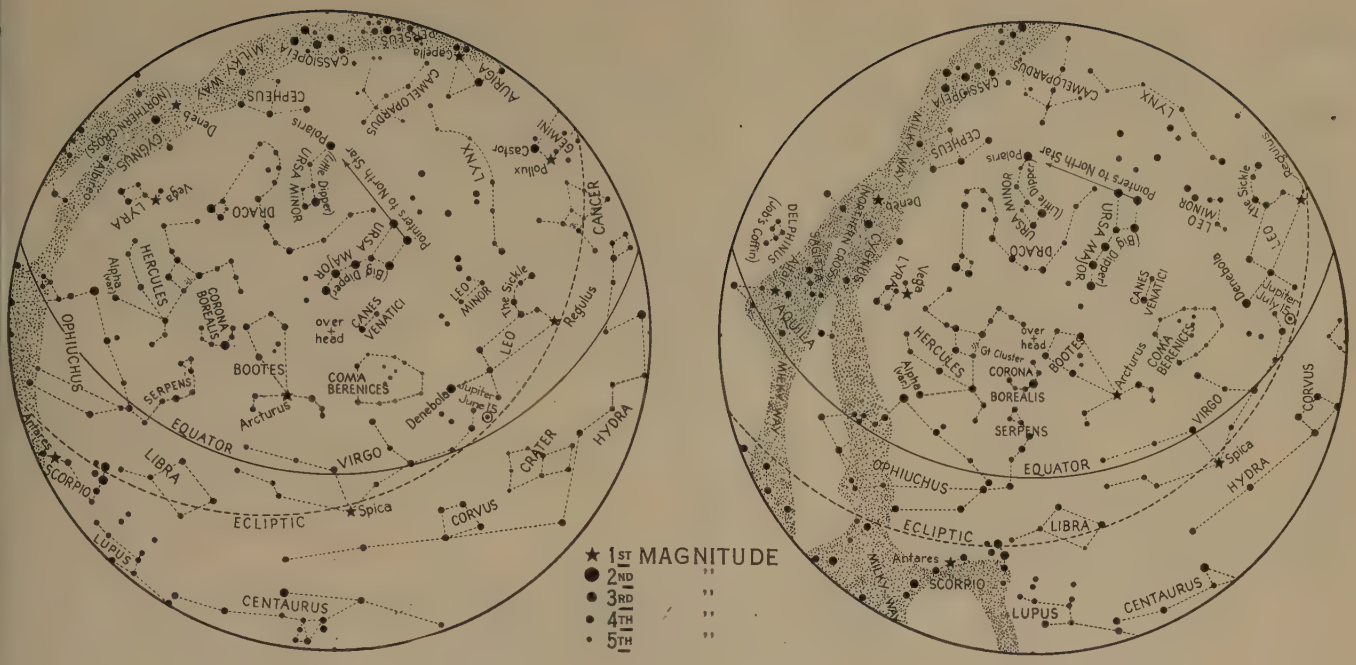
★

Shaving Mugs of Our Fathers

AROUND 1870 barbers' supply companies began importing plain shaving mugs, and somehow there was launched a vogue for decorating them, these adornments being fired and fused into glaze. Always individualists, American men found in this practice another way of expressing their individuality. They chose symbols of their occupations or their enthusiasms to decorate the mug that stood with others on the barber's shelf.

W. Porter Ware of Sewanee, Tennessee, has made a hobby of collecting these shaving mugs, more than one thousand outstanding ones in his possession now representing a bit of Americana that had to yield to new habits.

PHOTOGRAPH BY HERMAN HARRIS LAMB



9 P.M., June 1; 8 P.M., June 15.

9 P.M., July 1; 8 P.M., July 15.

To use these maps hold them before you in a vertical position and turn until the direction of the compass that you wish to face is at the bottom. Then, below the center of the map, which is the point overhead, will be seen the constellations visible in that part of the heavens. It will not be necessary to turn the map if the direction faced is south. Time given is Standard Time; add one hour for War Time.

The Evening Sky in June and July

By ISABEL M. LEWIS

THE mild radiance of the summer constellations has now replaced the glittering array of first and second magnitude stars in the well-known winter groups of Orion, Taurus, Auriga, Gemini, and Canis Major and Canis Minor. Brilliant Vega is now visible in the northeast in Lyra, and high overhead is the kite-shaped group in Boötes, with its orange-colored Arcturus, which will remain visible throughout the summer. In the south is beautiful, blue-white Spica in Virgo, the large rambling zodiacal constellation that roughly resembles a letter Y. Scorpio soon comes into view in the southeast and is, when well above the horizon and near the meridian, one of the finest of the summer constellations. Its first-magnitude star, Antares, is one of the largest of the red giants. Its long tail, outlined by many brilliant second magnitude stars, reaches almost to the horizon, and the entire constellation lies in one of the most brilliant parts of the Milky Way.

A small but conspicuous group in the evening sky at this time is the little semicircle of stars that forms Corona Borealis, the Northern Crown. Its brightest star, Alphacca, the gem in the Crown, is a star of the second magnitude. Hercules, one of the largest constellations in the heavens, lies directly east of Corona Borealis, and is overhead in the mid-latitudes of the northern hemisphere about nine o'clock in the evening in the early part of July. This constellation is outlined almost entirely by stars of third and fourth magnitude. Its brightest star, Alpha Hercules, is a star of the second magnitude. Ophiuchus, to the south of Hercules, also has only one star of second magnitude close to the star Alpha Hercules. It also is a constellation of great size, and its outlines are rather difficult to trace. The long winding constellation of Serpens is closely associated with Ophiuchus, which is known as The Serpent-Bearer.

During these two months Jupiter will pass from Leo into Virgo and will be conspicuous in the western evening sky.

Saturn is rapidly approaching the sun in June in the constellation of Gemini, and is in conjunction with the sun on July 6. By the end of July it will rise about two hours before the sun, and may be seen close to the eastern horizon before sunrise.

Venus will be in the morning sky in June and July, passing from Aries into Taurus. It is at greatest western elongation on June 24, when it shows the same phase as the moon at last quarter. It will be a brilliant Morning Star throughout this entire period.

Mars is also in Aries in June, and, early in the month, gets within about 5 degrees of Venus, after which they draw apart. Near the end of July it passes between the Pleiades and Hyades in Taurus. By that

time it is rising more than four hours before the sun. Its reddish color is in strong contrast to the dazzling white brilliancy of Venus. It will be equal to a star of first magnitude in brightness during this period.

Mercury is poorly placed for observation in June as it is in superior conjunction with the sun on June 15. It will gradually draw away from the sun in the evening sky after that date, and will be at greatest eastern elongation on July 23. This is not a favorable elongation for viewing the planet, however, as it will be 11 degrees above the western horizon at sunset.

The sun will be at its greatest distance north of the equator and summer will begin in the northern hemisphere on June 21, 2:52 P.M., Eastern War time, war or no war.

The total eclipse of the sun, which will occur on July 9, has been considered in detail in the May number of *Nature Magazine*. There will be a partial eclipse of the moon on June 25, magnitude 86 hundredths of the moon's diameter, which will be visible in the Pacific, Indian and Antarctic Oceans, Australia, Asia and southeastern Africa.

★

Orchids in the Dooryard

By ALEX D. HAWKES

An orchid is usually thought of as a huge, showy flower for which one pays an exhorbitant price at the florist's when a special dance or party warrants an unusual gift for a fair lady. But although there are many of the big orchids, there are many more little ones, with flowers of all colors imaginable — green, brown, red, yellow, white and even black.

PHOTOGRAPH BY RACINE FOSTER

Of the more than 20,000 known species of orchids, probably five-sixths have flowers so small that the average person, when shown one, would say, "Oh, poof, that's just a weed! It can't be an orchid! It's not big enough!" But the poor little flowers struggle on, being orchids and being appreciated only by a chosen few—the orchid collectors and the professional or amateur orchidologists.

In Florida we have more than eighty different kinds of orchids, all growing wild in our swamps, jungles and fields. Most of them are insignificant, and the one pictured here is no exception. Because it is very small, has no common name, and was not discovered in this country until 1937, *Zeuxine strateumatica* is known by only a few people in the state.

Perhaps the most interesting fact about this interesting orchid is that its native land is China. It was probably introduced into Florida about 1917, or later, when the first plants of the now common centipede grass, *Eremochloa ophiuroides*, were sent in from seeds collected in China several years previously by the botanical explorer, Frank N. Meyer.

Zeuxine is now a fairly common orchid in parts of the state, where, during the months of January, February, and March, the plants appear, as if by magic, in lawns, in roadside ditches and on the shores of lakes. Some of the most beautiful specimens that have been found were taken from the lawns of private homes, where this orchid grows and spreads with great rapidity in the thick mat of centipede grass.

The plant is rather small, but sometimes specimens as large as ten inches in height will be found, usually growing in moist ground. The flowers appear quite early in January and are rather small; they are reddish, yellowish, or greenish, and occasionally the entire plant, leaves and all, will be colored the same as the individual flowers. These blossoms last only a short time and are followed by small brown seed pods, which contain the myriads of powdery seeds that are blown to new localities by the southern winds.

These seeds are sometimes so prolific that the same seed produces two or more plants. This helps the plant to attain the goal it is rapidly approaching—the classification of an orchid as a weed, for in certain parts of Florida, notably the central area, *Zeuxine strateumatica* is becoming somewhat of a nuisance to those who want a neat lawn without straggly, reddish weeds sticking up through it.

Few people will believe that this innocuous little plant perkily peering up from their centipede grass lawn is an orchid—of all things! But it is, and this Chinese gift to America continues to thrive and multiply in its new home. Perhaps some day Florida can send one of her beautiful orchid species to China to enrich that nation's already bountiful supply of plants.

Camp Fire Girl Poets

For ten years the Camp Fire Girls have conducted an annual poetry contest, with many entries and a distinguished board of judges. For the tenth annual contest the judges were Joseph Auslander, Phyllis McGinley, Alfred Kreymborg, A. M. Sullivan, Audrey Wurdemann and Norman Rosten. After due deliberation they tossed the laurel wreath to seventeen year-old Betty Pearson for a long, blank-verse poem entitled "Pastoral Symphony." The poem is imaginative and Miss Pearson cleverly carries out her idea, but for our taste, which does not run to blank verse, we would pin the medal on Barbara Gray Fruth, also seventeen, the runner-up. Barbara calls her poem "City River," and, as a self-appointed, non-poet judge, we reprint it here:

A step away
Across the sandy, wood-rimmed ledge
The river dwells
At level with my quiet feet.
The golden day
Has long been vanquished by the night;
The darkened swells
Are glass where sky and river meet.
Bridges in the sky
Are pinned by light to heaven and earth;
The sleepy city
Blinks her eyes and tucks her buildings in.
Does the river lie
Thinking of its rural birth?
Does it have pity
For those who know but urban din?
Quiet, are its dreams
Of rustling banks of meadow grass,
Its bubbling start,
Silver hooks by blue-jeaned youngsters cast?
To me it seems
To love the city—not the lonely hills,
For in its heart
The diamond gleams and shadows are held fast.

Just a tip on future winners to watch in the Camp Fire Girl poetic sweepstakes is Dellene Stipp, who is only seven, but managed to place in the honorable mention group with an untitled bit that says:

Pretty little blue bird,
Sitting on a rail,
Winked his little eye
And ruffled up his tail.

Such contests as this are fine things, however, stimulating creative writing and bringing out the poetic instincts of young people. Camp Fire Girls, Inc., is making a splendid contribution through this contest, and it is mighty nice of the poet-judges to lend a hand, even if they do like prose dolled up to look like poetry. In justice to Betty Pearson, let it be said that she landed an honorable mention with a poem that rhymes and scans.

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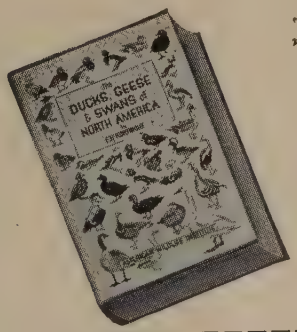

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The School Page

Edited by E. LAURENCE PALMER

Professor of Rural Education, Cornell University, and Director of Nature Education, The American Nature Association

SCHOOL LESSONS ON FUNGI

THIS afternoon, I spent a few hours on a passenger coach talking to a college professor of plant pathology whom I have known for years. Both of us had taken the same courses on fungi in our preparatory years. Both of us had had the experience of raising fungus *Penicillium,* and had noticed concentric areas of culture media around colonies of the fungus, but it had meant nothing whatever to either of us. For that matter, it had had no significance to our teachers either. Both of us wondered why we had never been shown, in our elementary and secondary school years, some of the fundamental things about the lives and relationships of fungi. There is not the slightest doubt that fungi are to play an increasingly important role in modern civilization, and there is not the least reason why youngsters cannot begin to make some progress in their understanding of these interesting organisms.

There is a variety of more or less standard school activities designed to help children understand fungi. Some of these are centered around the collection and classification of conspicuous and interesting forms. Some of them concern themselves more with an understanding of what fungi do. Some call for direct investigation, and some for reading about the findings of other investigators. Some deal with practical, economic problems, while others deal with intellectual understandings or with esthetic aspects. Most of these approaches to the study of fungi have been introduced in the special insert in this issue of *Nature Magazine.* Others have been developed in the references given at the end of that unit. It only remains here to suggest a few specific school activities that may be interesting enough, simple enough, and profitable enough to warrant teachers trying them out. We do not flatter ourselves that many teachers trained in established routines, and trying to discipline their pupils similarly, will be interested in these suggestions. We rather think, however, that established routines are not always most helpful in school routines, any more than they are in a democracy.

Making Collections

Children are constantly bringing things to school for help in understanding them. A scarlet cup fungus growing from a dead twig on the wet forest floor can be left alone only by those who like to see things left in their natural setting. But what can the teacher do with it when it is brought to school? Of course such a fleshy fungus could be preserved in some liquid preservative, but that might be impracticable. On the other hand, it might be dried thoroughly and quickly, but in either case it would quickly lose its attractive coloration and its significant shape. Something that would represent the original fungus might be cast and then colored, or it might be photographed, drawn or painted.

For the smaller fungi, it is suggested that schools make collections of specimens about large enough to fit into a small box. If the fungus is glued or wired to the bottom of the box, it will not rattle around and get broken while in use, and will remain reasonably characteristic for subsequent study. The small box may be covered with clean white paper on which appear the name of the fungus, the date, where it was collected and by whom. A very considerable variety of small fungi may be kept in a surprisingly small place if small boxes are used in this way. Of course, any larger box may be used for larger fungi. When it again becomes possible to obtain cellophane envelopes, it may be worth while to keep some collections in them, and, even now, cellophane may be salvaged and made into reasonably good containers.

Making "Spore Prints"

Some schools have enjoyed making "spore prints" of some of the commoner gill fungi. These are made simply, and are often interesting. The cap of some gill fungus that sheds reasonably dry spores is cut off and placed gill-side down on a piece of white paper. After it has been left for an hour or more, it may have made a print on the paper by shedding the spores. This print can be "fixed" by spraying with any of the common fixatives used by art teachers for spraying charcoal drawings. A collection of these prints, showing variation in color of spores and in gill and cap patterns, might be stimulating enough to start some youngster towards a better understanding of these fungi.

Some ambitious teacher may care to try to cast some of the gill fungi. The technique for doing this has been outlined in a number of books. It consists, in its simplest form, in cutting some bilaterally-symmetric gill fungus in half lengthwise and then pinning them together again, but with a card separating the halves. Wet plaster of paris, or clay, is then used to cover the fungus. When the plaster is set the two halves are pulled apart and the fungus removed from the plaster form. If this is then smeared inside with vaseline and fresh wet plaster poured into either side, the two halves may be pushed together. Then the forms may be removed, leaving a plaster representation of the original fungus. This may be smoothed off and colored properly, and may be duplicated indefinitely. Some of the larger gill fungi modelled in this way make interesting things to set about in formal gardens. In this case, it is best to cast a stick or wire into the base of the stem so that this may be thrust into the ground to hold the cast erect. Some schools may have the use of the more elaborate elastic casting equipment, and, if this is the case, they may make splendid reproductions of attractive fungi.

Drying the Fungi

If one wishes to preserve the fleshy fungi by drying them, it will be best to use a drying oven of some sort. This may be made by following the directions for making any of the common, homemade driers now recommended for drying garden vegetables. If one wishes to be even more simple in the matter, a set of perforated shelves placed over an electric hot plate may yield satisfactory results.

Teachers need have no hesitancy in encouraging children to further their studies of fungi because of fear that such activity might have no vocational importance. We already have professional "plant doctors," and we will have more. Bacteriologists, people who are engaged in storing perishable and valuable foods, those who make a living raising domestic plants and animals, industrialists who employ fungi to bring about certain chemical changes in the making of foods, plastics and many commercially important chemicals, must understand the nature of fungi. Housewives, doctors, grocers, clothing dealers, all may succeed or fail at times because of their understanding of fungi. And, best of all, we have only begun to understand their complete significance, as can best be illustrated by the revolutionary changes wrought by the development of penicillin.

We have in mind the preparation of a later unit on fungi for our series in which we will emphasize culture procedures, and, possibly, a study of microorganisms that cannot be seen individually by the naked eye but that can be easily recognized by the injuries they inflict, or when they are present in great numbers as colonies. Before we prepare any such unit of the series we would welcome the reaction of our readers to such a proposal. We have the material at hand. Children have worked with it, and we have some understanding of what is significant to them. The only question lies in whether other units might not be more universally appealing.

Highways and Trails

Conservationists view with justifiable misgivings some of the elaborate plans for road construction after the war. They are particularly concerned about the threat of more skyline drives and highways penetrating areas of outstanding scenic beauty and wilderness significance, and bringing in their wake the usual commercialization. There is another threat that the system of hiking trails jointly developed by organized hikers, the U. S. Forest Service, the National Park Service and some State agencies may suffer such "development." There are some who envisage jeeps traveling over these trails—as those hardy cars could do.

The existing trail systems, one of the most notable of which is the Appalachian Trail from Maine to Georgia, have been created carefully and laboriously. Many parts of such systems have no official standing and exist by sufferance of private property owners. To remedy this situation Congressman Daniel H. Hoch of Pennsylvania has introduced a bill, H.R. 2142, as an amendment to the Federal Aid Highway Act. He proposes appropriation of $50,000 for the "construction and maintenance within the continental United States of a National System of Foot Trails, not to exceed 10,000 miles in total length, to be devoted solely for foot travel and camping, which activities will develop the physical fitness and self-reliance of, and an appreciation of Nature in, the people of this nation, and serve as a part of the basic training of our youth for service in the armed forces." The proposal would, in other words, guarantee the integrity of the existing system, permit addition to it and, through annual appropriations, proper maintenance of it. We hope the bill is successful.

Youth Hostels

Ten years ago hosteling was unknown as a fact in the United States. Today there are 252 youth hostels in twenty-seven states. Postwar America should see a surge forward in this movement. Pointing out, in the March *Coronet*, that Youth Hostels, Inc., has made a start, Beardsley Ruml urges that "all Americans of high school age should have ten thousand miles of national travel as a part of their education. . . . Two million boys and girls a year between the ages of fourteen and eighteen should be given an opportunity by our people to know and understand their country." American Youth Hostels, Inc., apparently hopes to help meet this need. We are advised that those interested may obtain a free travel folder and a free historical folder from the organization, whose national headquarters are Northfield, Massachusetts. The 1945 AYH Handbook is available for twenty-five cents.

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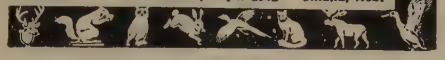

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SPIDER SILK—WONDER-STUFF OF NATURE

(Continued from page 292)

or silk spider, which makes enormous and very tough nets in shady woods in the southern states—it has never been possible to put spider silk on a commercial basis under American labor conditions.

The best use Americans are making of spider silk these days is for the cross "hairs" in telescopic sights, by which enemy craft can be precisely located in height-and-range-finders, and then blasted out of the sky. There are some ten or twelve specialists in the country raising spiders to produce the best sort of silk for this purpose. A strand of very even diameter is required, and it must be strong and inelastic. The ideal filament is the sort on which a spider lets itself down when escaping, and the best of these is produced by the type of spider that makes the despised irregular cobweb. This includes the dreaded black widow spider, who has probably saved more American lives than it has ever taken.

The black widow, the only spider anyone need seriously fear, can usually be recognized by its "shoe button" body—large, black, and shiny, with a red hourglass pattern on the underside. Black widows rarely bite except on their nests, and even then most people recover. So the chance that you will die of a black widow bite, even in regions where black widows are commonest, is more remote than that you will contract leprosy here in this country, or drown in your own baththub, or be murdered by the beneficiaries of your insurance.

Of course, all spiders are poisonous in the sense that they have a little drop of venom with which they paralyze their foes, but mosquitoes and bees are poisonous to that degree and are a lot commoner and more disposed to sting. Some people never get over their fear of spiders, and almost everyone calls them ugly. To my eyes, many of them are very quaint and some are quite beautiful. A spider in the corner brings more good luck than the cricket on the hearth. If you must fear or feel disgust at something, it would be more sensible to do so at sight of the common fly, who wipes his typhoid fever germs in your butter. Its sleepless foe is the spider — your friend and ally, day and night.

MOTION PICTURE ANIMALS HAVE A CHAMPION

(Continued from page 295)

need the caution and the awareness of a man trained to protect animals from possible risk of accident.

About one thousand horses, from two to three hundred dogs, and large numbers of wild animals, ranging from llamas to raccoons, are used exclusively for motion picture work. Most of the animals are owned by stables specializing in training their boarders for the movies.

Metro-Goldwyn-Mayer maintains its own zoo. The animals are provided with a kitchen and pantry that are as immaculate as a Dutch housewife's. The best of well-balanced foods are served. At this zoo are three generations of deer imported from Florida for the future filming of "The Yearling." Baby alligators laze in their own pond of swamp water. In the corrals is "Pi," the steeplechaser that Elizabeth Taylor races to fame in "National Velvet." Hundreds of thousands of dollars are tied up in these animals.

"The motion picture industry," repeats Mr. Craven, "is a smart business. The greatest of care, rest and precautions are given their stars be they Lassie or Bette Davis. The days of abuse, of dangerous stunts, such as the Running W and other tripping devices, are over. However, vigilance is needed by a humane expert to protect animals from possible risks called for in scripts. My job is to protect and advise."

THE MAGNIFICENT QUETZAL

(Continued from Page 302)

two turns at incubation accounted for about half the hours of daylight. Upon leaving the eggs when his mate came to replace him he would sometimes rise from the doorway of the nest on a long upward flight that took him well above the tree-tops, shouting as he rose syllables that sounded to me like *very good, very good, very good.* Then he would circle about and dive down into the sheltering foliage. These soaring flights seemed an outlet for his exuberant spirits, a release of the energy so long pent up as he sat motionless upon the eggs.

After seventeen or eighteen days of incubation, the eggs hatched. Like other new-born trogons, the young quetzals were blind and utterly naked, with no trace of down upon their pink skins. At first they were brooded much by both parents, and nourished chiefly with small insects. As they grew older and began to acquire plumage, they were given an amazing variety of food. There were large winged insects, including beetles that seemed to be made of solid gold; green larvae; small green and yellow frogs; small lizards; land snails, swallowed in the shell, which was later regurgitated; and fruits of several kinds, prominent among which were the hard, big-seeded, green-skinned fruits of the ira rosa (*Ocotea pentagona*), and other trees of the laurel family. While the nestlings were still naked and required much brooding, their parents kept the nest perfectly clean. But later, when the young quetzals could reach up and take their nourishment through the doorway and it was no longer necessary to enter the hole to feed them, the old birds ceased to pay attention to sanitation. Then the big, regurgitated seeds of these fruits, mixed with a smaller bulk of other waste materials, accumulated in the bottom of the cavity in such large quantities that they gradually raised the level of the floor, and each day the nestlings rested higher in the nest, nearer the doorway. At one nest, the litter was 3½ inches deep when the young birds departed.

In two high, inaccessible nests, the young quetzals lingered about a month before taking wing. But those reared in the lowest nest were removed for occasional examinations and to pose for their photographs, and probably as a result of these premature experiences in the open, departed at the age of only twenty-three days, when they were beginning to become green like their parents, and could fly very well.

Each of the three pairs of quetzals to which I devoted most attention reared, or attempted to rear, a second brood. Two of them laid the second time in the high, inaccessible holes where their first brood grew up, cleaning it out to receive the new set of eggs. But the third pair, whose lower nest had been destroyed after the successful departure of the fledglings, laid their second set in a very old and dilapidated hole in a neighboring dead trunk. This was the lowest nest of all, and here at last I could see the eggs and follow the development of the young birds. The mother of these nestlings unaccountably neglected them after they were about two weeks old, and upon their father fell the entire burden of feeding during their last week in the nest. He alone was seen to attend them after their successful exit.

And what happened to the gorgeous plumage of the male quetzal during this long breeding season that extended from the end of March to July or even early August? How did those long, delicate plumes of his train stand up through all the wear and tear of rearing two broods of young birds? For the most part, his ornamental plumes fared very badly. The constant flexing they received on innumerable passages into and out of the nest-hole, the friction against the rough edges of the single doorway, soon began to tell. Even before the young of the first brood were a-wing, some of the males had their plumes broken off short. So, while they incubated their second set of eggs, they failed to display the two green pennants which earlier had waved so proudly before the doorway, whenever they were within the nest performing their parental duties. They might show only the stub of a single plume, or

none at all. When I. took leave of the quetzals in August, after more than a year amid their beautiful but uncomfortably wet forests, they wore only the tattered remnants of their nuptial splendor.

But soon they would molt again into fresh plumage, bright and untarnished, proving that the loveliest of living things may engage in humble and exhausting tasks, yet in the end recover all their grace and refulgence.

Nature Card Games

By far the most attractive Nature card games that we have ever seen have come to hand from Mrs. Ruth Wheeler of Angwin, California. There are two of them—"Goldfinch," a bird game, and "Monarch," an insect game. Each one consists of sixty cards illustrating, in color, sixty birds and sixty butterflies or moths, respectively. The artist who did the work is Nellie Wilkinson, and the color reproduction is exceptionally good. The games may be played by from four to eight people, but we will not try to go into the rules, which, of course, accompany each game. They both offer an interesting way for both young and old to become acquainted with some of the birds and some of our most beautiful insects. The bird game has with it a little folder describing the birds pictured on the cards. There does not seem to be a similar folder with the butterfly game, at least there was not one with the pack that came to us. These games sell for one dollar each and strike us as making excellent gifts.

Sierra Committee

Recognizing the fact that exploitation of parks and forest, often appearing under the guise of " war necessity," will reappear as a threat through postwar "make-work" projects, the Sierra Club has created a conservation committee. It will be headed by Weldon F. Heald, and serving with him are Ansel Adams, Arthur Blake, Leland Curtis, Braeme Gigas, John Thomas Howell and Charlotte Mauk. Besides altertness on the defensive, the committee will support constructive projects in both park and forest administration.

Birthstones and Flowers

Birthstones and Flowers. By James R. Simmons. Boston. 1945. Meador Publishing Company. 57 pages. $1.00.

Forester by profession and poet by avocation and enthusiasm, James R. Simmons gives this little book of collected poems a unity of ideas by devoting a sonnet to each month, its birthstone and flower. To these he adds a number of other poems, almost all of them Nature verse that draws upon the poet's long acquaintance with the outdoors. This is a most attractive little book.

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VIRGINIA WAS ONCE ENGLAND'S WILD WEST

(Continued from page 320)

mammal fauna was the bird host, which filled the trees of early Virginia. The largest and most welcome of all the birds was the wild turkey. George Percy was the first one to see the evidence of the abundance of this creature. On the way up the James River that eventful spring of 1607, he was set ashore to explore a pretty river island. This bit of land turned out to be a regular turkey brooder-land. Everywhere he and his party walked they found turkey nests. They ate heartily of these first eggs, after a long sea voyage, and returned to their ship.

The wild turkey became one of the mainstays of the early settlers and explorers. By report, it often weighed thirty-five or forty pounds, and one author extravagantly claims that an occasional patriarch was invincible because of his seventy pounds.

When we walk through our modern quiet woods it is hard to realize how abundant these turkeys were. Lawson wrote of frequently meeting "great gangs of turkies." Now a man shivers in a blind for hours in the hope of glimpsing a few of these wary, wily birds.

Of course, far more abundant were the ducks and geese, which migrated as triumphantly then as now. Other game birds, such as quail and ruffed grouse, were readily to be found. However, in the presence of an abundance of larger creatures, these were largely ignored by early writers.

But these writers could not ignore the passenger pigeon, now extinct. Byrd marveled at the "prodigious flights of pigeons, so great that they darken the sky." The weight of their numbers, when roosting, broke even the large limbs of oaks. In their travels they stripped the woods of acorns and berries so that they left famine behind them. Under their roosting trees the ground was covered three inches deep with their dung.

The Indians used to visit these roosts by night and kill thousands with especially made, long poles. They collected the oil from these birds, while cooking them, and preserved it for use as butter on their cornbread. Even the smallest Indian village had at least one hundred gallons of pigeon fat stored away.

After mentioning all these important birds, Huguenot Durand de Dauphine indulged his Frenchman's love of the dainty by describing the hummingbird "which feeds on the dew and the juice of fragrant flowers, and smells so sweet." Too "sweet smelling" for its own good, apparently, since an enterprising Englishman had a number of the little birds baked and sent to England for sale as a delicacy at a ridiculous price.

We still have with us in abundance the hummingbirds and other songbirds, which delighted the senses of the first English settlers. Many of the other birds and mammals are little more than museum pieces now.

I am sad when I wander through my woods and see nothing alive but second-growth trees and sickly undergrowth. No glimpses of deer or bear or turkeys around a bend in the trail; no tracks of great and near-great wild animals in the mud along the stream; no beaver ponds and meadows. However, we should not sigh, I guess, for what had to happen; the wild things could not compete with rifle-bearing white men for the occupancy of the American soil. Nevertheless, we can at least save what is left of the wreckage our fathers wrought by encouraging and protecting the furtive wild creatures we still have.

CEIBA, KING OF TROPIC TREEDOM

(Continued from page 323)

resulting in 2,000,000 pounds of floss worth $400,000, was gathered and sent for processing to Petosky, Michigan, where the world's only milkweed-separation station has recently been completed by the Defense Plant Corporation.

Chemistry, too, made its contribution by producing a synthetic kapok that is considered in many ways superior to the original. A Du Pont plastic, it simultaneously finds its name and description in the term Bubblfil. Because of buoyancy provided by the cellular structure containing myriads of minute individual air spaces, it has been marked for military use in pontoons and life-rafts. Other obvious qualifications should make it a versatile kapok equivalent.

Whether these replacements become permanently established in our industry to compete with kapok, once it again enters the world market, is a question only the future and the war's end can answer.

Whatever may be kapok's fate, for all man's prowess in the art of substitution, and his genius for duplicating the wonders of Nature, "Only God can make a tree"—and you can say that again for the ceiba!

THE NATURAL HISTORY OF WATER

(Continued from page 316)

tasted (in the true sense of taste, comprising the sensations of sweetness, sourness, saltiness, and bitterness) only when in water solution; candy for instance must dissolve in the water of saliva before its sweetness may be tasted. Finally, water furnishes devices for maintaining equable internal temperature in animals. In cold-blooded species this regulatory function depends upon the facts that the living body consists largely of water, and that water can absorb more heat with less change in temperature than can any other substance. In the warm-blooded animals, water makes possible an even body temperature by serving as a cooling agent, through evaporation of sweat from the skin or of saliva from the tongue.

We have seen that water makes similar contributions to living organisms regardless of whether they dwell in water or in air. That land-living animals may, in fact, be descended from marine forms is suggested by chemical analysis of the body fluids of the former, which reveals that these fluids contain the same mineral substances, in the same proportions, as does sea water. Kinship of land- and water-dwelling animals is further suggested by considering development of the young. Fishes spend all of their lives in water, laying and hatching their eggs in that medium. Amphibians dwell part of the time on land, but their eggs usually are laid and their young are hatched and nurtured in water. Turtles, which are thought to be one evolutionary step above amphibians, lay eggs on land. But the interior of turtle eggs provides a watery environment for the embryo, closely resembling the surroundings in which amphibian embryos develop. The same is true of snake and bird eggs. Looking, finally, at the most highly-evolved animals, the mammals, which include man himself, we realize that within the mammalian uterus amniotic fluid provides the same aqueous environment for embryos. Thus it appears that when sea-dwelling animals invaded land, probably in the Cambrian period of geological time nearly five hundred million years ago, they brought with them, as part of their reproductive mechanisms, private ponds in which their young might develop. Apparently water provides an ideal environment for that most critical period of animal life, embryonic development.

Thus animal life, both in the embryo and in the adult, is totally dependent upon water. Plants likewise depend upon water throughout their lives. Although animals and plants dwell in a world that was shaped by water, misshaping of that world through erosion can and should be prevented. And despite all its abundance, water may never be taken for granted, for, in order that it may render maximum service to living things, water must be protected against pollution.

Florida Arbor Day

Confusion has reigned for some time as to just what day is Arbor Day in Florida. Schools have observed one day, the garden clubs another. Now the State Legislature has stepped in and settled the matter. Henceforth the third Friday in January of each year will be Arbor Day.

Community Forests

An active campaign is being fostered by the Ohio Forestry Association, an organization of citizens of Ohio pledged to the expansion, renewal, protection and proper use of the forest resources of Ohio, to further the creation of community forests. Such forests have, of course, proved immensely valuable in Europe, and Massachusetts pioneered the town forest idea successfully in this country. To stimulate interest and activity, the Ohio Forestry Association has brought out a little folder outlining the idea and answering questions. Copies may be obtained on request to Oliver D. Diller, Secretary-Treasurer, Ohio Forestry Association, Wooster, Ohio.

Against the Plow

With the publication of *Plowman's Folly* Edward H. Faulkner stirred up a good and healthy argument on farming methods. Being, he says, naturally lazy, as well as intrigued by Faulkner's ideas, Austin Welch of Canaan, New Hampshire, set to work to discover what happened if he left the plow and the weeder in the barn. In controlled plots he used different methods, photographing his results as well as recording them in notes. On the basis of this he has brought out a little booklet entitled "Plow Not—Weed Not," which is available from Mr. Welch for one dollar.

Income from Forests

Net cash receipts from National Forests reached a new high in 1944 with a total of $15,616,940, of which $12,622,946 came from the use of timber. The balance was derived from the use of forage and from special land uses. From this income $3,894,616 were paid to the States in which National Forests are located, and $1,557,846 went for roads and trails in National Forests. Except for a small sum for certain Arizona and New Mexico school lands, the balance went into the United States Treasury. The Olympic National Forest yielded the largest income of all the National Forests.

Rose Takes Over

One of the glories of Seattle is found in its flowers. Violet E. Cannon of that city reports on a rose that may make Portland, the City of Roses, jealous. She had been in the East for six weeks, returning home in August to find that a climbing rose that had been cut down when an addition to the house was built, had forced out putty between floor boards and grown up right in the middle of the house. No windows were near it, but the rose kept right on growing. Miss Cannon felt that such courage should not be thwarted and set about to make it follow a string behind the piano to a window. This is the only attention the rose gets, not even being watered.

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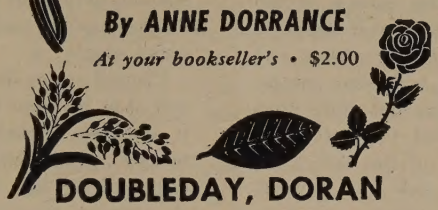

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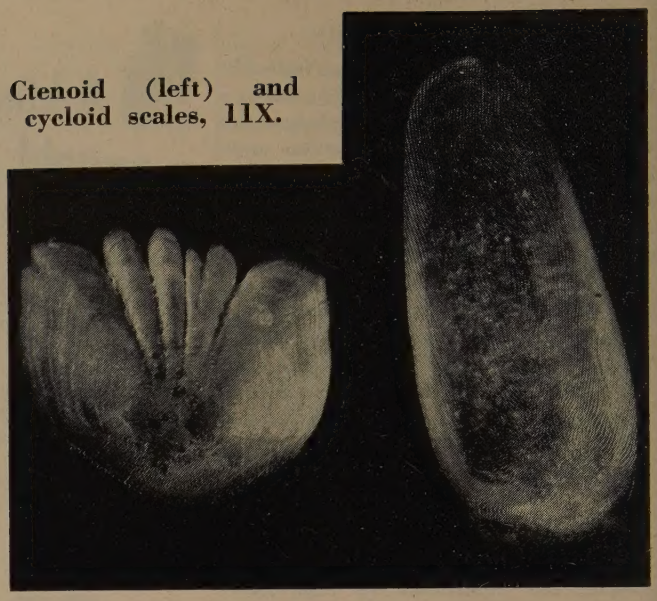
Under the Microscope

By JULIAN D. CORRINGTON

THE PHOTOMICROGRAPHS FROM SLIDES COURTESY OF WARD'S NATURAL SCIENCE ESTABLISHMENT.



Ctenoid (left) and cycloid scales, 11X.

SCALES AND SCUTES

One of the most interesting systems of organs in higher animals is the skin, or integumental system. From whatever point of view—in its comparative anatomy, physiology, or development—the skin is as complex as any other system, often more so. The integument separates the inner animal from its environment, and is that part of the body that must meet and cope with the surrounding world, whether water, soil, or air. It is accordingly this system that exhibits adaptation most readily and in most diverse manner.

The skin is a dual organ. The outer portion is the epidermis, derivative of the ectoderm, oldest and outermost layer of the early embryo. Beneath the epidermis lies the much thicker dermis or corium, which arises from the mesoderm, or "middle skin," of the embryo, and is composed of connective tissue, whereas the epidermis is an epithelium. The corium is the "true" skin from which leather is made; it is well supplied with blood vessels and nerves, and may contain bone and muscle. To adjust to various conditions, the vertebrate integument alters its thickness and number of layers, but more especially produces a large variety of specialized structures that may collectively be termed the appendages of the skin.

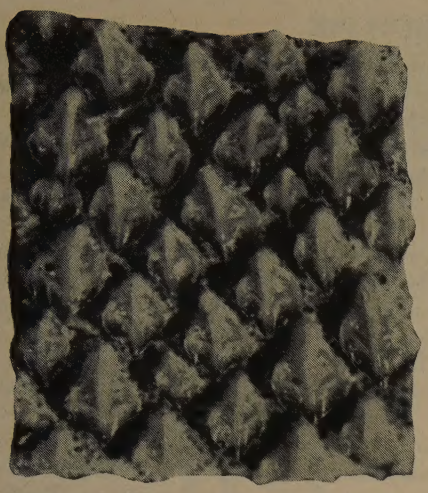
Appendages that arise in the epidermis and grow inward, pushing a fold of epidermis down into the corium, comprise the many forms of glands; others originate in or under stimulation by the corium, are related to the outer surface, and may be termed the hard parts. Some of these are entirely dermal, some wholly epidermal, and others made of increments from both layers; they are all protective in nature and take such diversified forms as scales, scutes, plates, dermal bones, teeth, feathers, and hair. The first three of these words have been much pushed about by anatomists and no uniformity of definition can be found. Take the term scale, for example—the scales of fishes and of snakes differ in all fundamental respects, as the following accounts will make clear.

The skin of the lowest living fishes, the lampreys, is devoid of any scales. These structures appear for the time in sharks as a minute object, the placoid scale, parent type of all other fish scales and of teeth (this Department, Jan., 1945). A placoid is composed of two parts, one from each of the two layers of the skin. A papilla or nipple-like elevation of the corium pushes up the overlying epidermis; connective tissue in the corium then manufactures dentine, a form of bone, comprising a quadrangular basal plate and an upward projecting spine; the epidermis covering the spine becomes a layer of enamel, hardest of all organic substance; a pulp cavity develops in the papilla, and the scale, like a tooth, has a blood and nerve supply.

Placoid scales do not touch one another; there are spaces of soft skin between them. Each scale lies between two ahead of it and two behind, making a group of five, an arrangement termed quincuncial. This allows the skin to wrinkle along either of the two diagonals, aiding in that flexibility required by sinuous muscle movements in swimming. All the spines slant to the rear, so that if a dogfish shark is rubbed with the hand from head to tail, the skin feels as smooth as velvet. On reversing the direction, however, the fingers meet the points of hundreds of tiny spines and the effect is that of sandpaper. As a matter of fact, shark skin, commercially termed shagreen, was long used by skilled workers to impart a final lustrous finish to such objects as furniture and billiard balls. It was the original sandpaper.

Some interesting implications arise from this study. The complete body covering of placoid scales constitutes an exoskeleton in sharks, and parts of this outside skeleton are destined to come into intimate relations and become incorporated with portions of the endoskeleton in higher animals. The endoskeleton or internal skeleton is the skeleton in the popular sense, as seen mounted in the laboratory. The shark's endoskeleton is entirely of cartilage; indeed, this is one of the major characteristics of the Class Elasmobranchii, to which all sharks, rays, skates, and chimaeras belong. One commonly reads that bone first appears in the ganoid fishes; the gross anatomist

Keeled (left) and plain snake scutes, 15X.



Placoid scales, dogfish shark skin, 20X.

has usually ignored the almost microscopic but bony placoids. Some fossil fishes, earlier than sharks, had a heavy bony armor.

In ganoids the basal plate of bone remains, but the spine is lost. Many plates fuse together to make large masses of bone in the skin of the sturgeon, variously and loosely termed scutes, plates, or ossicles. In the gar, the plates form rhombs that are slightly imbricated—shingled and overlapping, fitting together with a peg-and-socket joint that permits a bit of flexibility. These plates have a hard and shiny covering that suggests enamel, but on analysis is found to be dermal and not epidermal in origin, and, differing chemically from enamel, has received the name ganoin.

Teleost or bony fishes, comprising the vast majority of all living members of the finny tribe, have scales that consist of the basal plate only, without additional covering. These scales are relatively large and probably represent the fusion of a number of placoid basal plates. Two types were distinguished by Louis Agassiz, great Swiss-American student of fishes, cycloid and ctenoid. Cycloid (circular) scales, the more primitive, are simple, rounded, and tapering; they occur on trout and others of the lower orders of teleosts; ctenoid (combed; i.e., with teeth like a comb) scales have spine-like projections on the free, posterior margin, and are found on the higher fishes, such as the bass. Both types are imbricated, quincuncial, and show concentric lines of growth by which the age of a specimen may be known, in fashion similar to that of counting the annual rings in a tree trunk. In certain flounders the upper scales are ctenoid, the lower ones cycloid.

Among early ganoid fishes, those scales that covered the head fused into large areas that attained a constancy in size, shape, and relations to their neighbors, so that definite names could be given them, as rostral, frontal, parietal. These are commonly termed plates or scutes, though there should be no objection to calling them bones, since that is exactly what they are, and the names come largely from bones of the human skull. These flat bones covered over and protected the cartilaginous skull and jaws. As time passed, certain portions of the cartilage were eroded and replaced by other bone that developed in the endoskeleton; hence such bones are called cartilage bones by the comparative anatomist. The occipital bones at the rear of the skull are examples. In other places, the cartilage failed to develop and gave way to the new bones provided by the skin, hence called dermal bones, such as those of the top and front of the head and sides of the face, as the frontal, parietal, and maxillary.

Dermal bones and cartilage bones are both true bone and cannot be told apart from their gross or microscopic appearance, but only through their embryological history. The skull of man is accordingly a composite of ossified parts of the old shark cartilaginous cranium, plastered over on the outside by ganoid scales that in turn came from the placoid basal plates in the shark's skin—a wedding of endoskeletal and and exoskeletal parts. Dermal bones, next to teeth, are the most highly modified derivatives of fish scales.

Among the so-called scales of reptiles, those of a snake are not separate structures, as they appear to be, but localized areas where keratin or horn has been deposited in the other epidermal cells. These cells comprise a layer named for this reason the stratum corneum. It is described as heavily cornified (L., cornu, horn) or keratinized (Gk., keras, horn), meaning that during development the stratum corneum becomes more and more infiltrated with keratin granules until it is solid horny material, lifeless, impervious to water, and forming an excellent protective coat of mail. Keratin is seen also in nails, claws, hoofs, horns, feathers, and hair, products of the stratum corneum, and is chemically akin to sponge fibers, silk, and the chitin that forms the covering of insects.

The cornified area is continuous with a thin, uncornified portion of the snake's skin that tucks under the "scale" at the sides and rear, so that the cornified parts appear as separate entities, shingled and quincuncial in arrangement. The fact that these structures are not separate is well seen, however, in the cast skin of a snake, which is shed in one piece, or in an attempt to scale a snake as one would a fish; you will be unable to scrape off separate scales from a snake. Vertical sections of the skin, under the microscope, also show the true relations.

The term scute has been suggested for the snake scale, to avoid implying comparison with the true scale of a fish. Plain scutes are termed smooth; those

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with a longitudinal ridge down their center are keeled; the smooth-scuted snake appears polished and shiny, as the black-snake; the keeled-scuted snake has a rough and dry aspect, as the rattler. Belly scutes of snakes are enlarged to pass from one side to the other; under the body they are called gastrosteges; under the tail, urosteges (Gk., stege, covering). The gastrosteges are attached to ribs that are worked back and forth by muscles; their posterior edge is thin and sharp to catch upon irregularities of the surface on which the snake is crawling. In locomotion, a snake first uses the body as a fixed point and pulls the belly scutes forward; they grip the ground and then act as fixed points, the ribs being drawn back, thus pushing the body forward. Scutes can thus include even locomotion among their accomplishments. On the head of a snake, the scutes are enlarged into definite plates, which, like the dermal bones of a fish head, are of such constant size, shape, and position, as to receive names, usually drawn from the designations of the skull bones they cover, as nasal, frontal, parietal.

In lizards the scutes are similar to those of snakes, but are generally smaller. There are no enlarged gastrosteges and fewer and smaller head plates. The Gila Monster, among lizards, and all crocodiles and turtles are provided with dermal bones in the skin, underlying the cornified epidermis. Their scutes are juxtaposed instead of imbricated; that is, lie side by side like paving bricks, and grow by adding concentric extensions of the margin. Any turtle scute will show lines of growth.

In birds, feathers represent glorified scutes; there is hence a great elaboration of keratin in this class, as is true also in considering mammals and their hair. Scutes that are recognizable as such cover the legs and feet of birds. Turtles and birds have jaws covered with horn, to make a beak. In mammals, scutes appear on the tails of rodents, as rats and beavers, the tail of the opossum, feet of kangaroos, and as a complete dorsal covering of very large imbricated scutes in the curious pagolin. Armadillos have a bony exoskeleton.

Certain representatives among most vertebrate groups have lost their heritage of integumentary appendages. In eels, scales are present in the embryo, but disappear as development progresses; in catfishes there are none at all. Amphibians are scaleless save for very small imbedded plates in one small group, Among reptiles, the extinct ichthyosaurs of Mesozoic seas and the flying pterosaurs lacked scutes, while among living types, the soft-shelled and leather or trunk turtles have lost their scutes and even most of their bony plates. Embryo bears have an array of scutes as a transient marvel.

In summary we may contrast the scales of such a typical bony fish as the perch with the scutes of such a serpent as the garter snake. The scales are entirely of bone, a connective tissue product, are mesodermal in origin, and lie wholly within the corium; they are living structures, with living bone cells that must be supplied with blood vessels and nerves; they are covered with a thin, soft, living epidermis that secretes a mucous coating, and are not actually on the outer surface, as they seem to be; they screen the animal from an environment of water; they are separate, discrete entities that overlap one another with an imbricated and quincuncial arrangement, and exhibit lines of growth.

The scutes, on the other hand, are entirely of horn, an epithelial product, are ectodermal in origin, and lie wholly within the epidermis, though there is a dermal papilla beneath; they are lifeless objects composed of broken down, once living epithelial cells that die as they become infiltrated with keratin, and receive no blood or nerve supply; they are on the outer surface and are hard and dry; they screen the animal from an environment primarily of air; they are not separate structures but part of a continuous sheet, but by means of folds they partially overlap one another in shingled and quincuncial arrangement; in snakes, however, they exhibit no lines of growth.

Small wonder, then, that we believe the words scale and scute should be limited as here defined, and that the practice of referring to the "scales" of reptiles should be discontinued.

HISTORICAL OUTLINE

As Leeuwenhoek was the discoverer of bacteria, and Pasteur the founder of bacteriology, so Koch takes his place among the immortals as the father of bacteriological methods.

Heinrich Hermann Robert Koch (1843-1910) was educated at Göttingen, studying under Henle, previously mentioned in our account as the first to propose a germ theory of disease (usually credited to Pasteur) and first to formulate a set of rules to prove that a given organism is the cause of a particular disease (usually known as Koch's postulates). Graduating in medicine, young Koch went into practice and became the German equivalent of one of our county health officers, in Wollstein, Posen. The rural doctor was soon faced with a serious outbreak of anthrax, and did what few in his circumstances would have attempted—research in his spare time.

Anthrax is primarily a disease of cattle and related mammals, but is communicable to man and is often highly fatal; it is uncommon in America. The causal organism, *Bacillus anthracis,* is a long rod, very large in size as bacteria are reckoned, and seems to have been destined to play a major role in the development of bacteriology as an exact science. Discovered in 1849-50 by Pollender and Davaine, independently, in the blood of animals dying of the disease, it was the first microbe to be used in experiments on transmission, Brauell, in 1857, inoculating healthy animals with the blood of infected subjects and producing the disease in the injected hosts. Davaine, in 1863, performed a long series of researches that definitely proved these rods to be the cause of anthrax. Pasteur used this species for his famous experiment in artificial immunization by means of a serum, and Besredka likewise chose anthrax bacilli in developing his work on tissue or local immunization.

Koch, in 1876, took up where Davaine had left off. He grew the first pure cultures of anthrax organisms, and inoculated mice, producing anthrax in them; then discovered that when animals dead from this scourge were buried, the basteria formed resistant spores that could live for a long time, thus serving to infect the soil, later to be picked up by healthy animals. Koch hence demonstrated the life cycle of anthrax infection.

In performing this work, he noted certain handicaps and set himself to overcome them, in this way beginning a long and distinguished career as a pioneer in methods. At first Koch followed the procedures then current, mounting his organisms for examination on glass slips in a drop or two of serum, and cultivating them in a moist chamber. One factor that hampered observation of these minute plants was their movement, either that haphazard motion resulting from bombardment by invisible water molecules, termed Brownian movement (this Department, June-July, 1944) as with anthrax bacilli, or their own locomotion by means of flagella, as possessed by the germs of typhoid. He tried smearing his material on slides in the form of thin films and found that the specimens were fixed by instantaneous drying, without shrinkage or distortion. The bacteria was thus rendered motionless, so Koch next turned to the work of contemporaries for ideas in solving a second handicap, the transparency of these highly microscopic cells.

Cohn and others have used the natural dyes, carmine and hematoxylin, in histological studies; Perkins had discovered coal-tar or anilin dyes, and Ehrlich had improved them and invented new ones. The bacteriologist Weigert tried the methods of the histologist with these new anilin stains and, in 1875, achieved his first success with methyl violet, which he applied to sectioned material, finding that this dye brought out bacteria in tissues to excellent advantage. Koch adopted these practices with his films and soon made stained smears a standard technique in bacteriology.

The young country doctor won instant fame with his work on anthrax and his staining methods. In 1880 he was called to Berlin by the Kaiserliches Gesundheitsamt and quickly became its most influential member. Ample funds were made available for him and soon students flocked to his laboratories.